Evaluation

of the

Redline Stage

of the

Farmington Demonstration Project

Prepared by

U.S. Department of the Interior
Bureau of Land Management
Redline Evaluation Team

April 1987

Attachment

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United States Department of the Interior

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IN REPLY
REFER TO:

1268 (D-150)

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Memorandum

To: Bureau Management Team

From: Service Center Director

Subject: Redline Evaluation

Enclosed is a copy of the Evaluation Document for the Redline Phase of the Farmington Project. The purpose of the Redline was to determine the potential for integrating record, resource, and coordinate data using current hardware and software. It was a preliminary effort to provide information on automated requirements that will eventually be expanded through other efforts, i.e., the Blueline. The Redline, coupled with these other efforts, will objectively provide the Bureau with information pertinent to writing a Request for Proposal (RFP) for the target system. This would help the Bureau reduce the risks associated with procuring a comprehensive land information system to meet requirements for multiple-use management of the public lands.

The Redline was successful in meeting its stated purpose because it identified significant issues that need additional focus. Documentation of these issues such as data quality, data management, and standardization from a field perspective has provided us with valuable information that can be used to prepare the software RFP and implement a Land Information System (LIS).

The Bureau recognizes that the Redline alone is insufficient to identify all of our needs; therefore, efforts are continuing in the Blueline Phase of the Farmington Project. Off-the-shelf software packages and standards will be used in this Phase to obtain additional information for the software RFP.

We also recognize the fundamental nature of the Bureau's information, in particular, its land status and cadastral data which we have been sharing with the public and other agencies for over 200 years. As a result, the Bureau has committed to using common industry standards and will be actively assisting proposed software standards as well as data standards (such as the USGS Federal Graphics Exchange Format [FGEF]) in the Blueline Phase.

If you have any questions or require additional information, please contact Bob Ader or Judy Bright at FTS 776-0990 or Commercial (303) 236-0990.

Daniel R Peterson
ASSOCIATE

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EXECUTIVE SUMMARY

The Farmington Demonstration Project, approved March 7, 1986, had the following overall objectives:

- Define the strategy for the organization of unintegrated existing manual and automated record, resource, and coordinate data into a format for automation;
- Demonstrate, in a field office environment, the integration of records, resources, and coordinates using existing data bases, hardware, and software;
- Demonstrate the integration of records, resources, and coordinates using developmental software and new hardware;
- Define functional and system requirements for an interim Land Information System (LIS);
- Define benefit and cost "tradeoffs" between use of existing capabilities and developing capabilities;
- Further clarify functional and system requirements for a future LIS system and produce a written summary of results to integrate into the Bureau's Modernization Request for Proposal.

The Farmington Resource Area was chosen for the demonstration because of its large and diverse workload. Also, the Bureau believed LIS concepts should be tested in a field environment where more comprehensive potential Bureauwide applications could evolve.

In order to meet the objectives, the Demonstration Project was divided into two stages: the Redline and the Blueline. The purpose of the Redline was to demonstrate, in a field setting, the potential to integrate coordinate, record, and resource data into a single data base (the type needed for an LIS), using existing hardware and software. The Redline was completed on February 6, 1987, and is the focus of this evaluation. The Blueline, based on the findings of the Redline, will determine how much more capability can be attained using new, off-the-shelf software, such as Relational Data Base Management Systems (RDBMS).

The purpose of the Redline evaluation was to identify potential problems, issues, and trade-offs in developing a system using existing capabilities and to determine its applicability to other Bureau offices. The Application for Permit to Drill (APD) was selected as the vehicle for the demonstration because it represents a significant part of the Bureau's workload and because the requirements for processing data for an APD are similar to a number of other case processing functions in the Bureau. System capabilities and limitations, as well as significant evaluation findings and recommendations, are summarized as follows:

A. SYSTEM CAPABILITIES

The Redline demonstrated that selected alphanumeric records data can be merged with graphic resource data into a common data base which can be displayed graphically. The software is able, to a limited extent, to compute geographic locations and generate maps based on legal descriptions tied to the land net. This significantly reduces the need for digitizing some data themes. Additionally, data computed by the Public (land survey) Coordinate Computation System (PCCS) is more accurate than digitized data.

Macro commands were also developed which provided a much improved user interface to the system. These macros demonstrated the potential improvements possible for the user-machine interface in the future LIS.

B. LIMITATIONS

The Redline had several significant limitations. The software could not effectively sort, manipulate, and retrieve data stored in an alphanumeric data base. This was a direct result of not having a Relational Data Base Management System (RDBMS). Without an RDBMS, data manipulation capabilities of the system are limited and personnel are required to perform tasks with more labor-intensive methods. Additionally, the Redline lacked standard data exchange formats and software and was unable to easily reformat data from various other systems.

Although software performance was a limitation, it was overshadowed by a lack of data standards and standard data exchange formats. Identifying data standards and converting data files to standard formats took 80 percent of the time allocated for the demonstration.

Another significant limitation of the Redline was that the PCCS to Automated Digitizing System Conversion (PCCS2ADS) software was unable to compute boundaries of nonstandard townships (those with meander lines or metes-and-bounds descriptions). These types of townships would need to be digitized manually.

C. FINDINGS AND RECOMMENDATIONS

The most significant finding of the evaluation was the difficulty of loading data into a system because of the lack of data standards. Data conversion and data base construction were the most time-consuming aspects of the project. The biggest problem the Bureau will face in automating appears to be not what software should be developed or hardware purchased, but rather how the Bureau can efficiently develop data bases.

The Bureau must start developing and enforcing standards for all of its automated data immediately. Without standards, implementation of automated systems will be extremely complex and time-consuming. Therefore, the Redline Evaluation Team recommends that the Bureau create a Data Base Administrator in the Washington Office (WO-770) and in each State Office. These people will be responsible for developing data standards Bureauwide.

Other major recommendations of the Redline Evaluation Team include....

1. Capabilities demonstrated in the Redline should be converted from Data Generals (DGs) to Primes because...

a. A majority of the States will have Primes within the next several years.

b. The Prime contract may be modified to include an RDBMS, which was the major limitation of the Redline.

c. Many of the Redline utilities are being converted to Prime (Map Overlay and Statistical System (MOSS), Parcel Generator, etc.) so they can be used on the Blueline.

d. By the time the conversion would be ready for implementation, results from the Blueline should be available. This would enable the Bureau to decide which system best meets its needs without causing undue delays.

2. The special macros should be the last items converted because they would not be necessary if an RDBMS could be purchased.

3. The Redline should be maintained on only one set of hardware, the Prime, because resources for maintaining it on two sets of hardware are unavailable.

4. The Bureau must start developing and enforcing standards for all of its automated data immediately. Without standards, implementation of automated systems will be extremely complex and time-consuming. Therefore, the Redline Evaluation Team recommends that the Bureau create a Data Standards Manager in WO-770 and in each State Office.

The Redline project provided valuable experience and information to the Bureau because it demonstrated the potential advantages of an LIS. It has also helped to define areas where potential problems could occur in the development and implementation of an automated system. The Blueline stage of the Farmington Project will continue to help the Bureau evaluate the effectiveness of automation in the field as well as identify further issues associated with development and implementation of the follow-on system.

Chapter I

INTRODUCTION

A. PURPOSE

The Farmington Demonstration Project was approved by the Bureau Management Team (listed in Appendix A) on March 7, 1986. The project was divided into two stages, Redline and Blueline, to meet the following overall objectives:

- Define the strategy for the organization of unintegrated existing manual and automated coordinate, record, and resource data into a format for automation;
- Demonstrate, in a field office environment, the integration of coordinates, records, and resources using existing data bases, hardware, and software;
- Demonstrate the integration of coordinates, records, and resources using developmental software and new hardware;
- Define functional and system requirements for an interim Land Information System (LIS);
- Define benefit and cost "tradeoffs" between use of existing capabilities and developing capabilities;
- Further clarify functional and system requirements for a future LIS system and produce a written summary of results to integrate into the Bureau's Modernization Request for Proposal.

Understanding present LIS capabilities is crucial to the Bureau because it...

- provides a basis pertinent to developing an interim strategy before modernization and
- provides a basis for using the current system if Congress does not approve a new system.

The purpose of the first stage of the project (Redline) was to demonstrate, in a field setting, the potential to integrate coordinate, record, and resource data into a single data base (the type needed for an LIS), using existing hardware and software. This stage was completed on February 6, 1987, and, therefore, is the focus of this evaluation. The purpose of the second stage of the project (Blueline) will be to determine how much more capability can be attained using new, off-the-shelf software, such as a Relational Data Base Management System (RDBMS) along with a new generation of hardware. The Application for Permit to Drill (APD) was selected as the vehicle to be used in demonstrating these capabilities because it represents a significant part of the Bureau's workload and because the requirements for processing data for an APD are similar to a number of other case processing functions in the Bureau.

The purpose of this evaluation was to provide general descriptions of tasks, identify problem areas or issues, and discuss potential application of the Redline within the Bureau. Information from this evaluation will be presented to the Bureau Management Team for review and discussion of the Demonstration Project's overall objectives.

B. GOAL AND OBJECTIVES OF REDLINE EVALUATION

The primary goal of the project was to demonstrate, in a field setting, the effectiveness of using existing hardware and software capabilities to automate coordinate, record, and resource data. Its focus was to demonstrate how field personnel could increase productivity through automation.

To meet this goal, the following objectives were established:

- o Identify field data needs and processing requirements;
- o Construct an integrated data base (digitized data, maps, data dictionary, existing software, etc.) with existing systems;
- o Develop applications that complement the integration of data;
- o Test the effectiveness of existing capabilities and personnel to support an LIS in the Bureau;
- o Report findings.

C. SCOPE AND METHODOLOGY OF THE REDLINE EVALUATION

The evaluation focused on the requirements for developing an integrated data base and the requirements for using the current computer capabilities to process land-based information. Because projects such as the Automated Land and Mineral Record System (ALMRS) Feasibility Study and the Automated Resource Requirements Study (ARRS) have compared costs of manual and automated methods, this evaluation makes no such comparison. It does, however, verify estimates of cost-saving in the ARRS and Feasibility Study by comparing the costs of digitizing with the costs of running computational programs, such as Parcel Generator.

The evaluation focused on the capabilities used in developing the data base since approximately 80 percent of personnel time was devoted to this task. Many of the tools or capabilities examined, however, were determined useful for processing APDs and will be discussed from the user's perspective.

Finally, the evaluation examined applicability to the Bureau and discussed future considerations, such as conversion of current software systems to Prime computers.

The evaluation used a number of criteria to focus key questions that had to be answered for the Bureau Management Team. These criteria and key questions are listed below.

1. Criteria.

a. Ability to use existing records, resources, and coordinate data.

b. Ability to interface with existing Bureau software.

c. Ability to run on existing hardware.

d. Ability to use existing support capabilities to implement and maintain the system.

e. Ability of procedures to integrate record, resource, and coordinate data to support Bureau functions.

2. Key Questions.

a. What can/cannot the Redline do to assist in performing Bureau functions?

b. How efficient is the Redline in performing these functions?

c. What user support is required?

d. What hardware/software is required?

e. What data were required?

f. Is the Redline technology applicable Bureauwide?

g. What is the cost of converting the Redline from the Data General (DG) to the Prime?

The evaluation team comprised the following individuals, with invaluable participation from the Farmington Resource Area personnel as a separate effort:

Robert Ader	ALMRS/GIS, SC
Judith Bright	ALMRS/GIS, SC
Mike Candelaria	Farmington RA
Dana Collins, Contractor	Infotec Data Products (ORSO)
David Culley, Contractor	TGS Technology, Inc., SC
Dale Cummins	COSO
David Edge	AKSO
Jon Foster	CASO
Greg Graff	ALMRS/GIS, SC
Bruce Keating	WYSO
Jim Lavato	Farmington RA
Sam Montgomery	Farmington RA
Jeff Nighbert	NMSO
Louise Precosky	NMSO
Gary Speight	NMSO

Evaluations were conducted both at the New Mexico State Office (NMSO) in Santa Fe and at the Farmington Resource Area. Interviews with Gary Speight and Jeff Nighbert of Cadastral Survey and hands-on experience were used to gather information and document capabilities as well as problems and issues associated with the project.

D. ASSUMPTIONS

The following assumptions were made during the development, demonstration, and evaluation of the Redline:

- APDs represent the types of functions that need to be automated in the Bureau;
- Capabilities used and/or developed for the Redline (or some portion of it) could be implemented in the field;
- Coordinate, record, and resource data would be available;
- Costs for implementing the Redline would not reflect the costs for gathering or entering data;
- The Redline capabilities could be applied to more than APD processing.

Chapter II

CONFIGURATION

A. SCOPE OF THE REDLINE

The Redline initially focused on using the APD process as a vehicle for demonstrating the feasibility of using an LIS in Bureau field offices since it represents a "typical" Bureau function. Specifications on APDs were not completed in time to be used in the Redline, but selected tools for processing APDs were examined. Most of the efforts in the Redline were devoted to the integration of data. Therefore, data base construction and data manipulation were emphasized in the evaluation.

The Farmington Resource Area was chosen because of its large and diverse workload. Additionally, the Bureau felt that testing LIS concepts in a field environment would provide better information about potential applications in the Bureau. The extent of the data base was limited to nine townships in order to ensure manageability of the project in its early stages. These included Townships 22-24 North, Ranges 6-8 West, New Mexico Principal Meridian. Figure 1 shows the location and coverage of the study area.

The Redline primarily used existing NMSO hardware and software capabilities. One additional program was written for generating geographic coordinates of oil and gas wells from footage calls. This software was developed by TGS Technology, Inc., under contract at the Service Center (SC). Macros were also developed by using DG's Advanced Operating System (AOS), REV7.2, to assist with data reformatting and to improve and simplify the user interface for processing data.

The Redline effort required three major steps:

- Acquisition of Data: Data requirements were identified and requests were made to obtain information appropriate for the data base.

- Data Base Construction: Data were reformatted and loaded onto the DG; the data base was constructed for the nine-township area.

- Use of the System: Macros were developed and used to demonstrate tools available for processing an APD and for generating Master Title Plats (MTPs).

B. HARDWARE CONFIGURATION

1. Existing Hardware Configuration.

Most of the work was done on the DG Model M600 computer at the NMSO. This system was used for constructing the data base and for processing all land information. Additional tasks, such as retrieving Case Recordation and Status data, were performed on the Honeywell DPS8 at the SC.

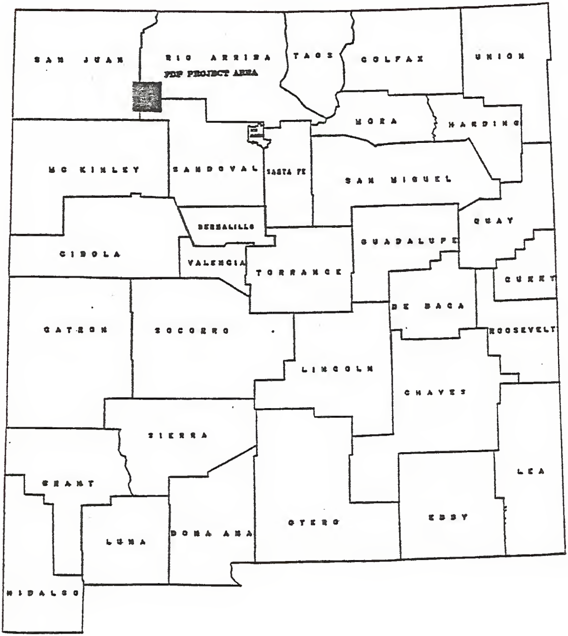

Figure 1 Location of the Farmington Project Area

Peripherals included the following:

a. Ramtek model graphics terminal

- o keyboard and Tektronix interface
- o 2 megabyte list memory
- o hardware zoom and pan

b. Tektronix Model 4111 graphics terminal

- o 1.2 megabyte list memory
- o 16 color planes
- o hardware zoom and pan

c. Tektronix Model 4696 inkjet printer

d. Zeta Model 3610 pen plotter

e. Assorted alphanumeric and Tektronix (Plot 10)-compatible graphic terminals

2. <u>Issue, Solutions, and Problems</u>.

Hardware problems centered around the Ramtek graphics terminal, which was ultimately not used for the project. The Ramtek terminal was purchased as a Tektronix-compatible graphics device. Compatibility depended on emulation software (Tektronix interface), which did not provide across-the-board emulation capabilities. Difficulties associated with getting the terminal up and running required three separate visits from NMSO personnel and numerous phone calls to Ramtek. The Ramtek terminal, although representing advanced technology for graphics capabilities, was not as user-friendly as the Tektronix 4100 series terminals. Documentation was also insufficient, significantly hindering support from the NMSO. Specific issues and problems associated with the Ramtek included...

- o Inability to move or turn off user dialog area;
- o Inability to scroll text in the user dialogue area;
- o Inability to assign color to text in dialog area;
- o Transmission and recall;
- o Incompatibility with macros written for the Tektronix;
- o High purchase and maintenance costs;
- o Difficulty in customizing menus.

These problems may not have been solely related to the Ramtek terminal; they may have been a result of the lack of knowledge or experience on the part of the Bureau. Training for the Ramtek, however, was expensive, with a minimum cost of $1,700 per trainee plus travel. Thus, the Tektronix 4111 was selected as a more cost-effective and user-friendly graphics device for the demonstration.

C. SOFTWARE CONFIGURATION

Software consisted primarily of existing GIS software packages and specialized macros written with the AOS. Other programs referred to separately in this document are conceptually part of the Geographic Information System (GIS) packages but have been written separately in FORTRAN 77 to expedite the transfer of software to Prime computers.

1. GIS Applications Software.

a. Automated Digitizing System (ADS)--Captures, displays, and edits mapped information in a vector/coordinate format.

b. Map Overlay and Statistical System (MOSS)--Processes and displays mapped information in vector or raster formats.

c. Map Analysis Package (MAP)--Processes and displays mapped information in a raster format.

d. Public (land survey) Coordinate Computation System (PCCS)--Computes geographic coordinates based on surveyed bearings and distances.

2. Separate Programs (FORTRAN 77).

a. Generate Geographic Well Location (GGWL)--Generates geographic coordinates for wells, based on legal descriptions (meridian, township, range, section plus footages).

b. Interactive Generation of Geographic Well Location (INTGGWL)--Provides a user interface to capture legal descriptions of well locations.

c. PCCS2ADS--Converts PCCS data to ADS and generates section lines for a township.

d. Parcel Generator--Generates land parcels based on legal land descriptions and land net coordinates.

e. PGFORMAT--Provides a capability to interactively create a file of legal land descriptions for Parcel Generator.

Systems operations and macro development were performed with DG's Command Line Interpreter (CLI) of AOS, Revision 7.2; Screen Editor (SED); SORT/MERGE; and Report Writer. Several macros were developed to set graphics terminal characteristics and to provide a simplified user interface; however, the primary purpose of the macros was to assist in reformatting data. Documentation of these macros is referenced in Appendix B, Sources of Documentation.

D. REDLINE SUPPORT AND RESPONSIBILITIES

The Redline was conducted primarily by the NMSO Cadastral Survey Branch, with assistance from other offices. Responsibilities for the project were as follows:

NMSO
- Identify data requirements;
- Provide status data;
- Construct the data base;
- Develop coordinate data base using Dopler and PCCS, in cooperation with the Colorado State Office and the Oregon State Office;
- Develop user interface of MTPs and APDs;
- Digitize additional resource data.

Albuquerque District Office
- Provide oil and gas panel maps;
- Digitize initial resource data.

Farmington Resource Area
- Assist in defining data base and user requirements;
- Provide resource maps for digitizing.

SC
- Provide FORTRAN programming;
- Provide Case Recordation and status data;
- Process Digital Elevation Model (DEM) data.

USGS, Division of Water Resources
- Provide Petroleum Information, Inc. (PI) data.

USGS, Division of Mapping
- Provide DEM and transportation data;
- Provide hydrography data

The NMSO utilized a limited number of personnel for the demonstration project. The vast majority of the effort was carried out by Jeff Nighbert, Branch of Cadastral Survey (NMSO). Many offices in the Bureau do not have personnel with the skills exhibited by the Cadastral Survey staff for constructing the GIS data base. A thorough knowledge of ADS/MOSS and DG's operating system and utilities, along with computer systems support staff, was required. Although preliminary efforts were made to prepare data and selected programs, most of the accomplishments were conducted over an 8-week period, from December 1986 through January 1987.

Chapter III

ACQUISITION OF DATA

Acquiring data for the Redline demonstration involved many different internal and external agency sources. This chapter describes the specific data required to perform the Redline demonstration, the planned and actual sources of data, and the experiences encountered in data acquisition.

The data needs were derived from the Bureau's APD process. These requirements included coordinate, record, and resource data.

A. ACQUISITION PROCEDURES

1. Coordinate Data.

Base coordinates for townships were acquired with a variety of methods. Digitized and generated coordinates were collected at the NMSO, while computed coordinates from surveys were provided through the cooperative efforts of the New Mexico, Colorado, and Oregon State Office Cadastral Survey staffs. The methods used are listed below:

- o Generating generic rectangular coordinates (based on a standard township).
- o Digitizing from U.S. Geological Survey (USGS) 7 1/2-minute quad maps.
- o Computing coordinates based on satellite positioning and conventional survey methods.

2. Records Information.

Records information was requested from three sources:

- o Status data were requested from the ALMRS Coordinator in the NMSO. Status was downloaded from the New Mexico ALMRS data base, reformatted for DG compatibility by TGS at the SC, and delivered on tape.
- o Case Recordation data were requested of the ALMRS Project Office at the SC.
- o Panel maps were requested in hardcopy (nondigital) format from the Albuquerque District Office. These maps portrayed the boundaries of Communitization Agreements (CAs), Unitized Agreements (UAs) with participating areas, and Known Geologic Structures (KGSs).

3. Resource Information.

Resource information was requested from three primary sources:

- A number of resource data themes were already available in digital format at the NMSO as a result of a Resource Management Plan. Available themes included cultural sites, paleontology, mineral ownership, and wildlife habitats. No data transfer was required in this case since the data existed on the DG computer.

- Resource maps were obtained from the Farmington Resource Area for digitizing. Since the original maps could not be released to the State Office for digitizing, the data had to be transcribed onto USGS 7 1/2-minute topographic maps for shipment. Map themes included roads, allotment boundaries, and range improvements.

- The request for PI data was made to USGS, Division of Water Resources by the District Office, while acquisition of other themes through USGS was coordinated through the ALMRS Project Office. PI data were delivered to the NMSO and DEMs were delivered to the SC for pre-processing with the Interactive Digital Image Analysis System (IDIMS). These data were not used because of conflicting priorities and time constraints. Transportation and hydrography data were not delivered from USGS. (Transportation was digitized after nondelivery was evident.)

B. ISSUES, PROBLEMS, AND SOLUTIONS

The Redline experience showed that data acquisition deserves considerable attention in future projects. The delays, resulting from late delivery or nondelivery of data, placed serious time constraints on the project. In these cases, a third party was usually involved. While this may not have been the only reason for inadequate response, it almost certainly complicated communications. USGS also did not respond to requests in a timely manner; transportation and hydrography were not delivered at all and DEMs were delivered late.

C. RECOMMENDATIONS

Third-party arrangements for data should be avoided. Requests should be made in writing and contingency plans should be made where there is evidence of potential problems. Knowing early in the process that data will be late or not available would allow for other arrangements to be made. Every attempt should be made to establish and maintain direct communications with data sources and to work on potential problems early in the process.

Adequate time must be allowed to acquire data, especially where data will be obtained from other sources, such as USGS. Since delays can seriously affect project success, time estimates for data acquisition must be as accurate as possible.

D. SUMMARY

Data for the Redline needed to be acquired from many different sources. Because of project time constraints and communication problems, some of these sources did not provide the data within the time allocated. Furthermore, the scheduling prohibited other arrangements from being made. These problems indicate that (1) adequate time must be allowed to acquire data or to make alternative arrangements for data, (2) communications need to be improved, and (3) third-party sources should be avoided whenever possible.

Chapter IV

DATA BASE CONSTRUCTION

Constructing a data base for the Redline involved manipulating data, using existing computer hardware and software, developing new programs, and identifying potential computer applications. This chapter describes and evaluates the types of data obtained and their usability, as well as the types of hardware and software used, their applications and interface.

A. COORDINATE DATA

1. Description of Procedures.

Record bearings and distances obtained from the resurvey field notes were entered into the PCCS program to produce a digital file of adjusted Universal Transverse Mercator (UTM) geographic coordinates for each township. (Survey data collection evaluation procedures and costs of different methods are detailed in Appendix C.) This file, produced on the SC Honeywell DPS 8, was reformatted and transferred to the NMSO DG M600 to use the graphic capabilities of present ADS Rev. 7 and MOSS software. (Figure 2 shows a sample file created with PCCS.)

Because this procedure is new, the data format needed to run the PCCS2ADS program on the DG computer was incorrect. Several SORT/MERGE macros were written to correct record length and record delimiters as well as to make changes to octal format.

The PCCS2ADS program was used to convert geographic coordinates for section boundaries into a line map which was further manipulated in ADS to produce a township map of the Public Land Survey System (PLSS). Figure 3 shows a sample township output product. Coordinates that do not lie on a section boundary were converted to ADS as a symbol file. The Parcel Generator program was then used to correctly subdivide sections, using only coordinates falling on section boundaries. Although interior section coordinates were transferred to ADS as a symbol file, they were not used by the Parcel Generator. This allowed Land Recordation data to be used with the township grid to generate geographically referenced maps. These maps showed land ownership, oil and gas leases, KGS areas, UAs, CAs, and well locations by using a variety of line types, color, and shading. An additional product of this procedure is acreage computations. These products (maps) can be stored, accessed, and plotted by Public Land Record users with very little computer experience. The ADS maps were then transformed into MOSS where they could be used as base maps for resource analysis. Figure 4 shows the flow of the data base construction process used in the project.

2. Problems, Issues, and Solutions.

The actual experience with this process was encumbered by nonstandard data exchange formats. The PCCS file, transferred to the DG, was visually reviewed before PCCS2ADS was executed and some incompatibilities were corrected using SED. Specifically, changes were made to record length and carriage returns were added. When the file appeared correct to PCCS2ADS import specifications, the program was executed.

400200	361641.0	1074039.5	6800.	10	30	259488.284017915.310
400240	361707.1	1074038.7	6800.	10	30	259530.874018719.280
400300	361733.2	1074036.7	6800.	10	30	259553.384019524.860
400340	361759.3	1074039.5	6800.	10	30	259561.094020327.340
400400	361825.3	1074039.9	6800.	10	30	259568.814021129.820
400440	361851.3	1074039.3	6800.	10	30	259604.204021931.770
400500	361917.4	1074038.8	6800.	10	30	259639.594022733.710
400540	361942.9	1074039.7	6800.	10	30	259638.334023520.890
400600	362008.4	1074040.6	6800.	10	30	259637.064024308.060
400640	362033.9	1074041.7	6800.	10	30	259632.724025094.080
400700	362100.7	1074042.8	6800.	10	30	259628.124025922.530
440100	361548.8	1074007.0	6800.	10	30	260254.064016282.710
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440400	361824.9	1074007.9	6800.	10	30	260365.844021094.670
440500	361916.7	1074007.0	6800.	10	30	260431.094022691.240
440600	362008.0	1074009.1	6800.	10	30	260423.854024273.700
440700	362100.7	1074010.8	6800.	10	30	260425.824025897.900
500100	361548.7	1073934.7	6800.	10	30	261062.024016259.550
500140	361614.8	1073934.8	6800.	10	30	261079.834017064.670
500200	361641.0	1073935.0	6800.	10	30	261097.664017869.790
500240	361707.1	1073934.1	6800.	10	30	261141.664018674.620
500300	361732.9	1073934.4	6800.	10	30	261156.884019469.840
500340	361758.7	1073935.2	6800.	10	30	261159.874020264.710
500400	361824.4	1073935.9	6800.	10	30	261162.874021059.580
500440	361850.2	1073935.6	6800.	10	30	261192.734021854.220
500500	361916.0	1073935.3	6800.	10	30	261222.584022648.850
500540	361941.8	1073936.4	6800.	10	30	261216.604023444.120
500600	362007.6	1073937.5	6800.	10	30	261210.634024239.400
500640	362033.4	1073938.1	6800.	10	30	261216.834025034.250
500700	362100.4	1073936.8	6800.	10	30	261223.374025868.730
540100	361548.7	1073902.3	6800.	10	30	261869.964016236.460
540200	361640.9	1073902.7	6800.	10	30	261903.574017845.900
540300	361732.9	1073902.2	6800.	10	30	261959.914019448.430
540400	361824.6	1073903.9	6800.	10	30	261961.864021043.750
540500	361916.2	1073903.6	6800.	10	30	262013.854022632.550
540600	362007.6	1073905.6	6800.	10	30	262005.954024216.970
540700	362100.2	1073906.4	6800.	10	30	262030.734025841.250

Figure 2 Sample File Created with the PCCS Program

(UTMs appear in far right fields.)

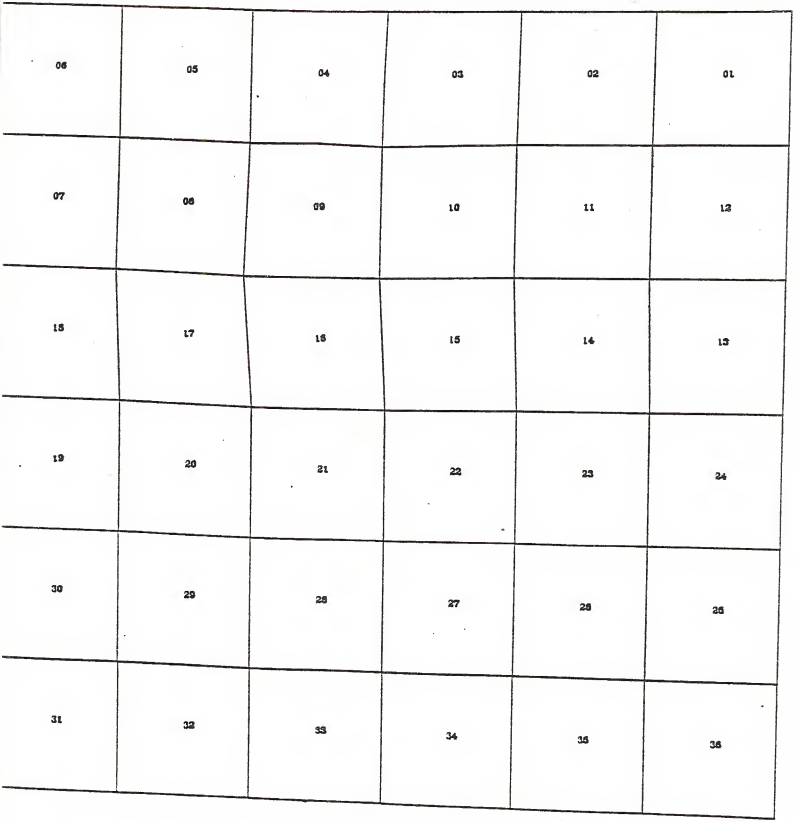


Figure 3 Product Generated after PCCS2ADS and CLOSEPOLY were executed (This product is a geographically referenced map of the section boundaries in a single map.)

COORDINATES DATA FLOW

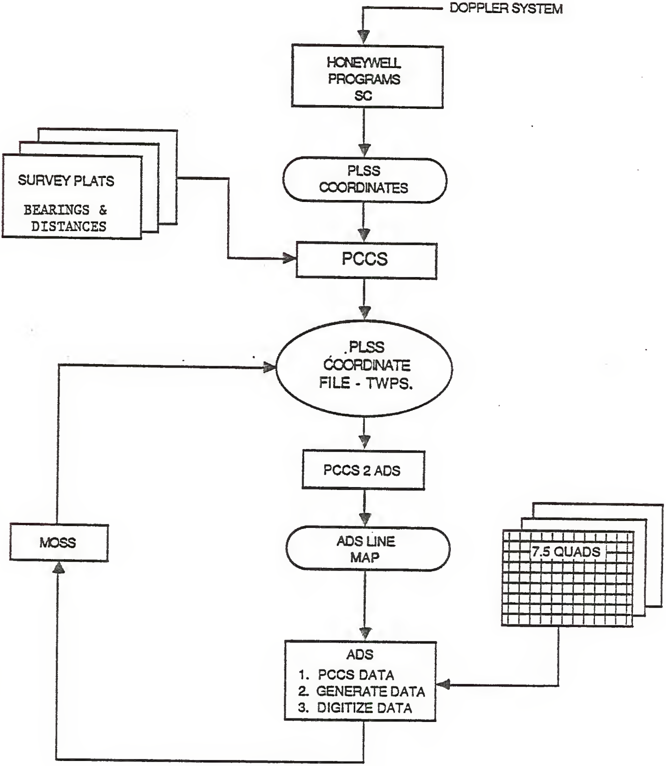


Figure 4 Coordinate Data Flow Diagram

The first attempts to execute PCCS2ADS failed because of nonstandard octal ASCII formats which could not be visually detected. To correct the problem, a macro was written by the NMSO, entitled OCT.SORT. This macro was used to convert Honeywell ASCII to standard ASCII format. PCCS2ADS was then successfully executed. The ADS function to form polygons ran successfully, and the resulting files were then added to the MOSS data base.

One shortcoming of PCCS2ADS was that it handles only standard townships and generates section lines based on the coordinate coding method in PCCS. Thus, some section boundaries can be generated incorrectly, requiring limited edits to be performed in ADS. PCC2ADS cannot process townships containing meander lines or metes and bounds. The only option presently available in these cases is to digitize the information. Additionally, coordinate locations that do not fall on a section boundary (coordinates interior to the section) are not utilized by Parcel Generator to produce maps from records data. Only coordinates that lie on section boundaries are used. Interior coordinates are computed based on standard roles for subdividing by aliquot parts and regular lottings.

For those coordinates used to generate the graphic in Figure 3, the associated reliability factors resulting from the transfer are from 10 to 30 feet. This means that coordinate or map point represents an on-the-ground accuracy of from 10 to 30 feet of its actual location. Efforts have been completed, however, to improve the PCCS2ADS conversion to maintain the data accuracy found within PCCS.

PCCS2ADS only handles UTM coordinates; the capability of working with state plane coordinates would enhance data integration.

PCCS is designed to be an interim coordinate base that will eventually be incorporated into the geographic coordinate data base. PCCS is currently being run on an SC DG MV4000 computer; however, its available data are estimated at less than 50 townships, Bureauwide. PCCS and ADS are currently being converted to the Prime.

3. Recommendations.

a. The requirement to change the record length and to add carriage returns resulted from miscommunication of tape specifications between those needing the tape in the NMSO and those generating the tape at the SC. This problem can be avoided by transmitting written requirements with proper tape specifications.

b. The PCCS output file from the Honeywell was not in standard ASCII format. A "band-aid" approach to this problem was to write a macro and use it for the conversion. Use of macros in these types of situations is time-consuming and difficult for the average user; therefore, these kinds of macros or similar programs should be automatically executed through data conversion and remain invisible to the user. Its incorporation and automatic application within data transfer procedures should be explored.

c. PCCS2ADS cannot currently handle nonstandard townships. While the number of such townships represent a relatively small percentage of all townships in the West, the capabilities that would be required to accommodate meanders and metes and bounds could also apply to mineral surveys and rights-of-way. The capability to incorporate the products of coordinate geometry, as well as other coordinate data, should be pursued as a means to

overcome this deficiency. Adding this capability would greatly increase the potential for applying the system: (1) States where metes and bounds are used, (2) for integrating unsectioned survey data, and (3) for use in areas where meanders are prevelant, such as Alaska.

d. Parcel Generator does not use coordinates interior to section boundaries to create maps. The capability to use interior coordinates needs to be developed in order to make full use of survey information and to generate the most accurate maps possible from records data.

e. Information contained in the geographic coordinate data base should meet at least most of the needs of private and public users. In addition, the user interface and indexing system (i.e., the ability to select information by township, range, section, county, and state) should be compatible with commonly used conventions and data formats. File formats and process procedures should be standardized and documented for both the Prime and the existing DG computers. A universally formatted data base would allow data to be retrieved interactively by a number of different computer systems.

B. RECORDS DATA

1. Description of Procedures.

Parcel Generator was used to generate digital maps from alphanumeric legal descriptions and land net coordinates. The input data format required for Parcel Generator was modeled after Legal Land Description (LLD) Status collection standards. These formats include status types L, 9, A, and 3. Other LLD/Status data formats are flagged as errors. (For additional information, refer to the Parcel Generator User Guide.)

Status data were provided in a standard, fixed length, ANCI-ASCII format, which required inserting one additional blank space at the end of each record to allow for its use in Parcel Generator. The format for collecting status is defined in the Status Coding Handbook, using Application 2002 of the Data Element Dictionary. Figure 5 shows an example of the status data format. Oil and gas lease information from Case Recordation was provided as "raw" data, which required development of three macro programs to sort and reformat the data for use on the DG with Parcel Generator. Figure 6 shows an example of reformatted Case Recordation data. The KGS, CA, and UA legal descriptions were interpreted from the hardcopy panel maps and coded into the DG using PGFORMAT so they could be used by Parcel Generator. Records data were processed with Parcel Generator to produce graphics of surface ownership, oil and gas leases, KGS, CAs, and UAs. Figures 7 and 8 show patented lands and oil and gas lease boundaries, respectively, which were computed by using Parcel Generator. Figure 9 displays the data flow for records information.

2. Problems, Issues, and Solutions.

a. Standardization

One of the major problems encountered was the lack of standards for collecting and entering data. Surface ownership and oil and gas lease information had been collected, in various formats, prior to the Redline. Additionally, data field sizes were free-form instead of standardized for oil and gas lease information. As a result, the information had to be sorted and reformatted before it could be used.

011900NMSF	061156	1230240N0060W005L		1,2,7,8;
011910NMSF	061156	1230240N0060W006A	X	
011920NMSF	061870	1230230N0070W003A	XX XX	
011930NMSF	061870	1230230N0070W003L		1-4;
011940NMSF	061870	2251104PA1081211 02061936942900		
011960NMSF	062968	1230230N0060W0249		
011970NMSF	062968	2251104PA1077554 08131935942900		
011990NMSF	062969	1230230N0060W0259		
012000NMSF	062969	1230230N0060W0259		
012010NMSF	062969	2251104PA1076353 06181935942900		
012030NMSF	064348	1230220N0060W0019		
012040NMSF	064348	2251104PA1067534 12281933942900		
012060NMSF	066677	1230230N0060W022A	XXXXXX	
012070NMSF	066677	1230230N0060W027A	XX	
012080NMSF	066677	2251104PA1090155 05141937942900		
012100NMSF	066846	1230230N0060W0189		
012110NMSF	066846	2251104PA1075420 04181935942900		
012130NMSF	069815	1230240N0060W022A	XXXX	
012140NMSF	069815	1230240N0060W015A	XX XXXXXXXX XX	
012150NMSF	069815	2251400PA1109801 12021940942900		
012170NMSF	069832	1230240N0060W001L		5-12;
012180NMSF	069832	1230240N0060W001A	XXXXXXXX	
012190NMSF	069832	2251104PA1112343 10201941942900		
012210NMSF	070117	1230240N0070W012A	XX X	
012220NMSF	070117	1230240N0070W001A	XXX XX	
012230NMSF	070117	1230240N0060W006L		5,11-14;
012240NMSF	070117	1230240N0060W006A	X X	
012250NMSF	070117	2251104PA1104124 08021939942900		
012270NMSF	075065	1230230N0060W020A	XXX XXXX	
012280NMSF	075065	1230230N0060W021A	X	
012290NMSF	075065	2251400PA1119906 08061945942		

Figure 5 Example of Status Coding and Formats

9NMSF	0078925	2 PASF78925	
4NMSF	0078957	1230240N0060W004L	1-4;
4NMSF	0078957	1230240N0060W005L	1-4;
4NMSF	0078957	1230240N0060W003L	1-4;
4NMSF	0078957	1230240N0060W006L	1-4;
9NMSF	0078957	2 PASF78957	
4NMSF	0078959	1230240N0070W007L	3,4;
4NMSF	0078959	1230240N0070W0073	SE,E2SW;
9NMSF	0078959	2 PASF78959	
4NMSF	0078974	1230240N0070W7073	E2NW,NE;REL
4NMSF	0078974	1230240N0070W707L	1,2;REL
4NMSF	0078974	1230240N0070W0223	S2NW,N2SW;
9NMSF	0078974	2 PASF78974	
4NMSF	0079086	1230240N0060W0143	N2;
4NMSF	0079086	1230240N0060W018L	1-2;
4NMSF	0079086	1230240N0060W0133	NWNW;
4NMSF	0079086	1230240N0060W035L	2-5;
4NMSF	0079086	1230240N0060W0103	N2N2,S2;
4NMSF	0079086	1230240N0060W0249	
4NMSF	0079086	1230240N0060W0233	S2;
4NMSF	0079086	1230240N0060W0183	NE,E2NW;
4NMSF	0079086	1230240N0060W0353	NWNW;
9NMSF	0079086	2 PASF79086	
4NMSF	0079428	1230240N0060W0293	N2NE,S2NW,E2SE;
9NMSF	0079428	2 PASF79428	
4NMSF	0080034	1230240N0070W0193	E2NE;
9NMSF	0080034	2 PASF80034	
4NMSF	0080107	1230240N0070W0343	NW;
9NMSF	0080107	2 PASF80107	
4NMSF	0080107A	1230240N0070W0333	SE;
9NMSF	0080107A	2 PASF80107A	
4NMSF	0080202	1230240N0070W0243	S2NE,S2;
9NMSF	0080202	2 PASF80202	
4NMSF	0080202A	1230240N0070W0243	N2NE;
9NMSF	0080202A	2 PASF80202A	
4NMSF	0080202B	1230240N0070W0233	SE;
4NMSF	0080202B	1230240N0070W0263	NE;
4NMSF	0080202B	1230240N0070W0353	E2;
9NMSF	0080202B	2 PASF80202B	
4NMSF	0080230	1230230N0070W005L	5-9;
4NMSF	0080230	1230230N0070W0053	SWNE,S2NW,S2;
9NMSF	0080230	2 PASF80230	
4NMNM	0080273	1230230N0070W0233	NE,SW;
4NMNM	0080273	1230230N0070W003L	7-10;
4NMNM	0080273	1230230N0070W009L	1-4;

Figure 6 Example of Case Recordation File reformatted to Status Types L, 9, A, and 3 Data Formats

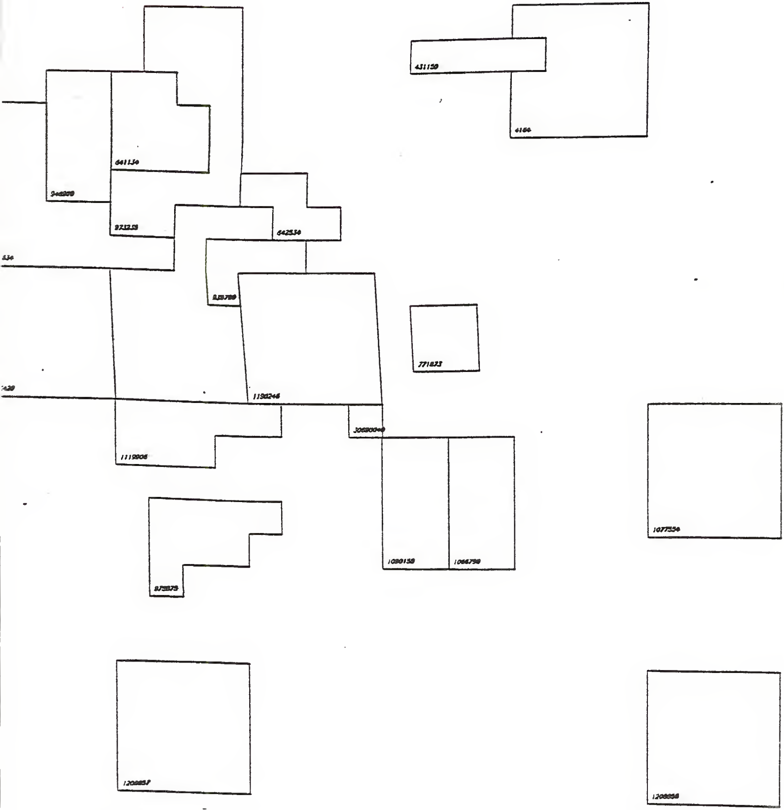


Figure 7 Patented Lands Map depicting the Computed Graphic, produced with Parcel Generator

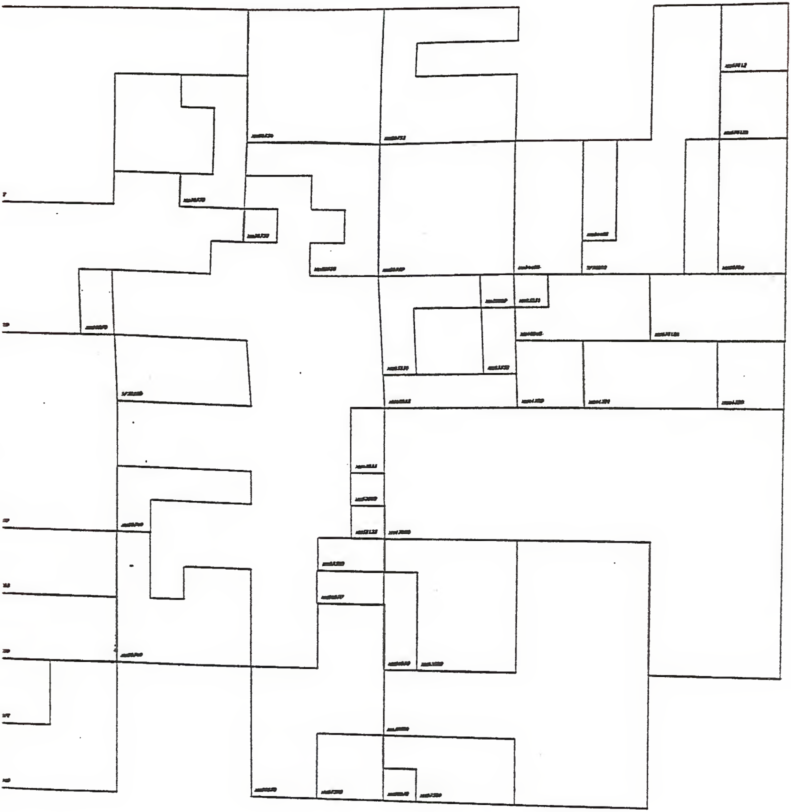


Figure 8 Oil and Gas Lease Boundary Map depicting Computed Graphic, produced with the Parcel Generator

RECORDS DATA FLOW

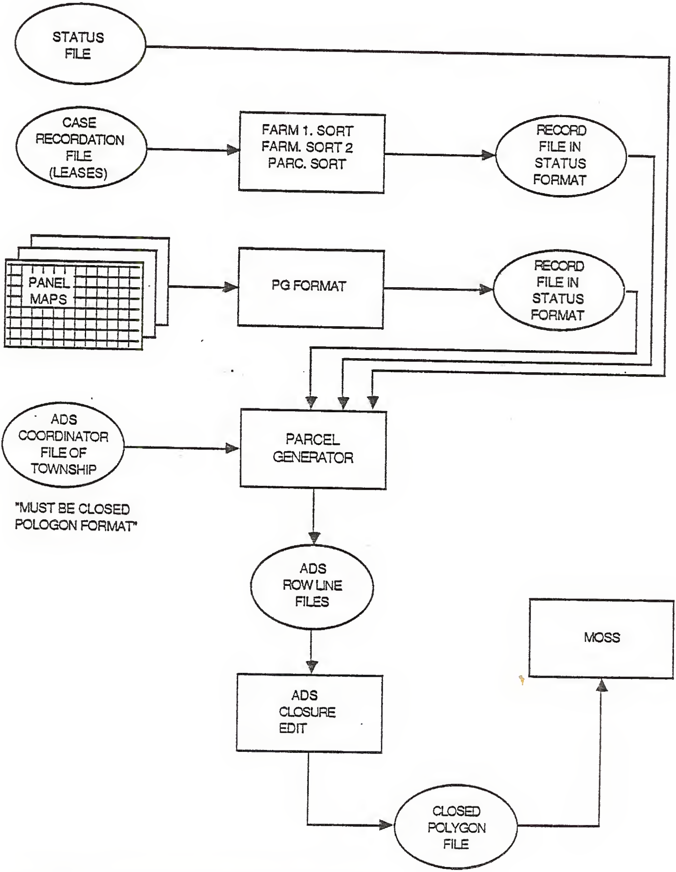


Figure 9 Data Flow for Records Information

b. Time

Oil and gas lease information was received 8 weeks after requested, partially because programs had to be developed to retrieve only oil and gas data from the more extensive Case Recordation files at the SC. The development of programs for sorting and retrieving data, and the subsequent processing of the data at the NMSO to standardize exchange formats, required a considerable amount of time. Many of the sorting and retrieval requirements could have been handled more effectively with an RDBMS. Additionally, skilled programming support was not available at the NMSO; therefore, development of the macros required a considerable amount of time.

c. Parcel Generator Limitations

Although many benefits of using the Parcel Generator software with oil and gas lease information data were demonstrated as part of the Redline, many limitations were also identified. The data, including leases, KGSs, CAs, and UAs, were generally described in normal legal conventions relating to all, aliquot parts, and regular lots. However, when data were described by distance and bearings, offset measurements, or descriptive free formats, the Parcel Generator software could not interpret the descriptions. While the free-format descriptions (e.g., excluding..., 60 paces..., south of the river) will require entering data manually, distance and bearings and offset measurements capabilities could realistically be developed for the software.

The existing Parcel Generator software also has difficulties dissolving duplicate lines where legal descriptions for the same lands are given more than once, resulting in additional editing using ADS. If not edited, the overlapped areas become separate polygons when CLOSEPOLY is executed.

In order to maximize the use of Parcel Generator, it must be used with entire townships; however, the user may specify individual sections. If an entire township is not included on a USGS quad, data in the sections that fall on quadrangle boundaries must be captured by digitizing in ADS. To avoid this situation, a program called EXTRACT has been developed that retrieves the appropriate portions of a township from multiple quads and merges them together. The resulting township can be effectively used by the Parcel Generator. Accuracy of the generated data, when using Parcel Generator, depends on the accuracy of the land net. PCCS computes the most accurate land net.

(d) Updating

An operational concern is keeping Case Recordation data current. Once the case records were processed to produce graphics, using the data tape from the Honeywell DPS 8, the dynamics of the case records were lost. The ability to update alphanumeric case records and graphics must be recognized as a vital link in the system. An RDBMS would accommodate this requirement for all alphanumeric data including case recordation. Case records must be continually updated to reflect actions occurring on the leases via State adjudication decisions because these actions affect field decisions on post-lease activity.

3. Recommendations.

The conversion of land record information, such as oil and gas lease boundaries, from legal descriptions in the case recordation files to geographic locations, was a significant component of the Redline. This conversion effort utilized existing oil and gas lease information from Case Recordation along with the Parcel Generator software, reducing the need for digitizing and demonstrating the capability to merge records data with resource data.

The Parcel Generator software is based on standard aliquot parts surveying conventions. Past experiences indicate that the Parcel Generator will probably be effective in 80 percent of the applications where legal descriptions and land net follow these conventions. The remaining 20 percent represents nonstandard surveying situations which will require editing or digitizing. Parcel Generator must be used with the most accurate land net data available--PCCS.

With the capability to convert legal descriptions to geographic locations, the Parcel Generator can be used in an array of other potential applications, such as providing check plots to assure the accuracy of legal land records, automating MTPs, and improving graphic accuracy by incorporating current survey information from PCCS, thus reducing the need for digitizing maps for most LIS projects.

The primary issue with Case Recordation data concerns data usability. Because data were collected in a nonstandard format, sorting and reformatting were major problems. The data provided from Case Recordation should be made available in a standard format by developing a sort/reformat program to increase its immediate utility. This is dependent on the establishment and adherence to data standards by all Bureau offices. The availability could also be significantly improved by allowing the State Offices with current systems, e.g., Parcel Generator, to access and copy files, rather than only obtaining reports.

Improving data management and manipulation capabilities will require the adoption of an RDBMS that allows the user to select and use specific multiple data themes from a single file rather than from multiple files of single data themes. Case Recordation files must also be maintained and updated with the potential of eliminating invalid or duplicate case records.

C. RESOURCE DATA

1. Description of Procedures.

The APD checklist provided guidance for establishing resource themes in the data base. Resource themes included threatened and endangered species, allotment boundaries, hydrography, roads, slope, paleontological sites, wildlife habitats, and range improvements. As described in Chapter III, some of the data were drafted on maps in the Farmington Resource Area office and some inventories, such as range improvements and cultural surveys, were incomplete. Since the existing data were assumed to be current and accurately mapped, no pre-entry verification was performed. The maps were duplicated

manually and copies were sent to the State Office for digitizing. PI well data were obtained from USGS. The elevation, roads, and hydrography data were also ordered from the USGS. Only the elevation data were delivered, but not in time to be used for the demonstration. This section describes the entry procedures used for this resource data and experiences obtained from this demonstration.

Resource maps from Farmington were sent to the State Office for digitizing with ADS. Following the digitizing, the data were moved into a MOSS data base.

The PI well data, obtained from USGS (these data had been reformatted by USGS), were furnished on magnetic tape in a flat-file text format. The file was loaded and the DG SORT/MERGE utility was used to search for and identify missing records. The wells in the file were located by footage calls from section lines that had to be converted to geographic coordinates before they could be added to the GIS data base. The GGWL program was written for this conversion.

The GGWL program computed the coordinates of a well by referencing the ADS map of the PLSS grid and applied footage calls from the PI file. Before the data could be processed with GGWL; however, the file had to be reformatted. The attributes for each well, beyond a well identification number, were removed and placed in a separate text file using the SORT/MERGE utility, after which the GGWL program was executed. The coordinates for 300 wells in the region were computed in about an hour. The product was an ADS point map.

ADS was used to create a device file which plots maps at the screen significantly faster than the MOSS PLOT command. The file of well attributes, created in the reformatting procedure, was used as a multiple-attribute file. This allowed map items to be selected based on multiple attribute criteria. Figure 10 displays data flow for resource information.

2. Problems, Issues, and Solutions.

In addition to footage calls for well locations, geographic coordinates were available from PI. To assess the quality of both the available and computed coordinates (using GGWL), a single map was created showing the well locations from both sources. (See Figure 11 for location data.) A program entitled PI2MOSS was used to import the PI coordinates. The resulting map was compared to photogrammetrically derived well locations and PLSS corner positions. The coordinates computed using GGWL were significantly more accurate.

The problem of nonstandard ASCII formats again appeared in this process. The PI files furnished from USGS had to be manipulated to be DG/ASCII-compatible. The solutions for this problem were the same as those cited in the earlier descriptions of the incompatible ASCII formats.

The data had to be reformatted before the GGWL program could be applied. Again, file manipulation (using SORT/MERGE) was required of the user before processing could proceed. Unfortunately, the required manipulation can be unique to a file, not allowing the application of the SORT/MERGE commands to be executed in a macro mode.

RESOURCES DATA FLOW

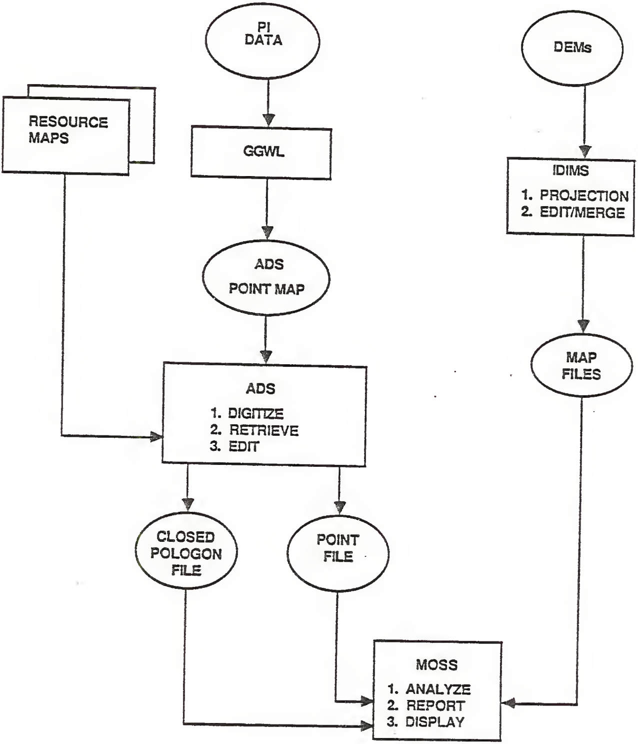


Figure 10 DataFlow for Resource Information

05579	07	24	N	06	W	1733	N	1147	E	1
05580	09	24	N	06	W	1850	N	1850	E	1
05581	09	24	N	06	W	1750	N	1650	W	1
05583	08	24	N	06	W	1750	N	1750	E	1
05587	08	24	N	06	W	1750	N	890	W	1
05588	09	24	N	06	W	1750	N	790	W	1
05590	08	24	N	07	W	1980	N	1980	W	1
05591	10	24	N	06	W	1650	N	990	W	1
05602	08	24	N	06	W	1090	N	1650	E	1
05604	11	24	N	06	W	1115	N	1560	W	1
05605	10	24	N	07	W	990	N	1000	E	1
05607	10	24	N	07	W					1
05609	12	24	N	06	W	965	N	1840	W	1
05620	06	24	N	06	W	840	S	840	W	1
05630	05	24	N	06	W	890	S	990	E	1
05631	03	24	N	06	W	990	S	1650	E	1
05632	05	24	N	06	W	1100	S	1650	W	1
05634	02	24	N	06	W	990	S	1190	E	1
05636	01	24	N	06	W	990	S	1750	E	1
05638	03	24	N	07	W	1650	S	1650	W	1
05641	01	24	N	06	W	1673	S	1840	W	1
05642	02	24	N	06	W	1850	S	1750	W	1
05651	01	24	N	06	W	2175	N	1850	E	1
05653	03	24	N	06	W	1650	N	1090	E	1
05654	04	24	N	06	W	1672	N	1750	W	1
05655	03	24	N	07	W	1650	N	1650	E	1
05661	02	24	N	06	W	1494	N	1050	W	1
05666	02	24	N	07	W	1190	N	990	W	1
05667	02	24	N	06	W	1650	N	990	E	1
05670	04	24	N	06	W	1190	N	1500	E	1
05672	01	24	N	07	W	990	N	790	E	1
05673	01	24	N	06	W	1600	N	1550	E	1
05674	02	24	N	07	W	990	N	990	E	1
05675	01	24	N	06	W	1190	N	990	W	1
05676	04	24	N	07	W	990	N	790	E	1
05677	03	24	N	06	W	990	N	990	W	1
05679	01	24	N	06	W	990	N	990	W	1
05680	02	24	N	06	W	704	N	1870	E	1
05681	02	24	N	06	W					1
20018	04	23	N	07	W	1830	S	1700	E	1
20048.	03	23	N	07	W	1650	S	700	W	1
20110	11	24	N	07	W	1850	N	790	W	1
20148	18	24	N	07	W	990	S	1650	W	1
20231	02	24	N	07	W	1050	S	990	W	1
20245	30	24	N	07	W	990	S	990	E	1
20269	11	24	N	07	W	1850	S	1700	W	1
20282	01	24	N	07	W	1650	S	1650	E	1
20282	01	24	N	07	W	1650	S	1650	E	1
20443	22	24	N	06	W	990	N	990	W	1

Figure 11 PI Legals for Wells

The PI data had a number of missing records that required "dummy" records to be inserted, again requiring manual manipulation. The GGWL program should be modified to handle PI input file record problems.

PI data are both record and resource data, as these have not only location information, but well history information. Location information was valuable for plotting the wells, but well history is needed for analysis when processing a new APD, e.g., formations, casing, aquifers.

The elevation data were delivered just prior to the demonstration, and were, therefore, not used.

3. Recommendations.

The ASCII standard provided on the PI tape and the DG ASCII standard were not compatible. Standard ASCII formats would eliminate the problem of having to reformat for the DG.

The GGWL program cannot handle PI files with missing records. The files must be manually manipulated by the user before the program can be run. The GGWL program should be modified to accommodate missing records.

Delivery dates and progress on data ordered from outside sources should be regularly checked. The roads and hydrography could have been digitized using ADS if the inability of USGS to deliver these data had been discovered in time.

MOSS cannot merge and edit DEMs. These capabilities in MOSS would remove the requirement for preprocessing in IDIMS.

D. SUMMARY

Construction of the Redline data base surfaced many new applications as well as identified areas needing improvement. The conversion of land record information to geographic locations was a significant component of the project. The Redline showed that information could be graphically presented without digitizing and proved the capability to merge records data with resource data.

Individual software generally performed well in controlled situations. The Parcel Generator, for example, works well in 80 percent of the applications and can potentially be used to assure the accuracy of legal land records, automate MTPs, and increase the graphic accuracy of plats.

Transferring data from one computer to another was not always successful. However, several "band-aid" macros were developed to convert, sort, retrieve, and process data. These macros could potentially be used in other Bureau applications and their use should be explored.

The data used to construct the data base were sometimes incomplete or inaccurate. In addition, data formats varied. Much time was spent sorting and reformatting information so it could be used. Since data formed the basis of the demonstration, the problems encountered reinforced the need for the Bureau to develop and establish specific data standards. Improving data management and processing will require the development of new software or an RDBMS as well as consistent Bureau standards for collection and input of data.

USING THE SYSTEM

Capabilities for using the system to process land information were reviewed by the evaluation team and personnel from the Farmington Resource Area. While the evaluation team focused on general capabilities to process data for both APDs and MTPs, Resource Area personnel concentrated specifically on using the system to process APDs. The NMSO provided user assistance to these efforts.

A. DESCRIPTION OF CAPABILITIES

The PCCS promoted a quality check on the original survey notes and was used to flag errors and make corrections. Using survey methods and PCCS has significant advantages over digitizing methods because of the accuracy of coordinate locations and quality control checks for survey data. The digitizing method requires significantly less capital dollar investment to collect information; however, data inaccuracies could lead to significant costs related to lawsuits or loss of royalties.

Macros were written to simplify the user interface for processing data. The macros provided the users with a set of menus from which a number of options could be selected. An example of the APD menu is as follows:

Main Menu for Processing APDs

- Adjudication
- Fluid Surface Management
- Resource Mitigations
- Graphics Display
- Reports
- Drill Hole Engineering
- Exit

These macros were used to access files and GIS programs to perform specific tasks. Although GIS programs or commands were executed, their use was invisible to the users. Thus, minimal training was required to use the system for functions listed on the menus.

Work was conducted with a Tektronix 4111 graphics terminal which provided good facilities for examining, displaying, and working with geographic data. The capabilities were much improved over the equipment currently being used by other Bureau field offices.

B. ISSUES AND PROBLEMS

The macros used for retrieving, processing, and displaying land information were considered easy to use and appropriate for processing APDs. Minimal training was required for all individuals; however, timeframes did not allow for development of all macros or programs required. These programs were necessary to manipulate the alphanumeric data base and would have required a

significant effort to develop. An RDBMS would have satisfied most of these requirements and would have reduced the amount of time related to handling all information.

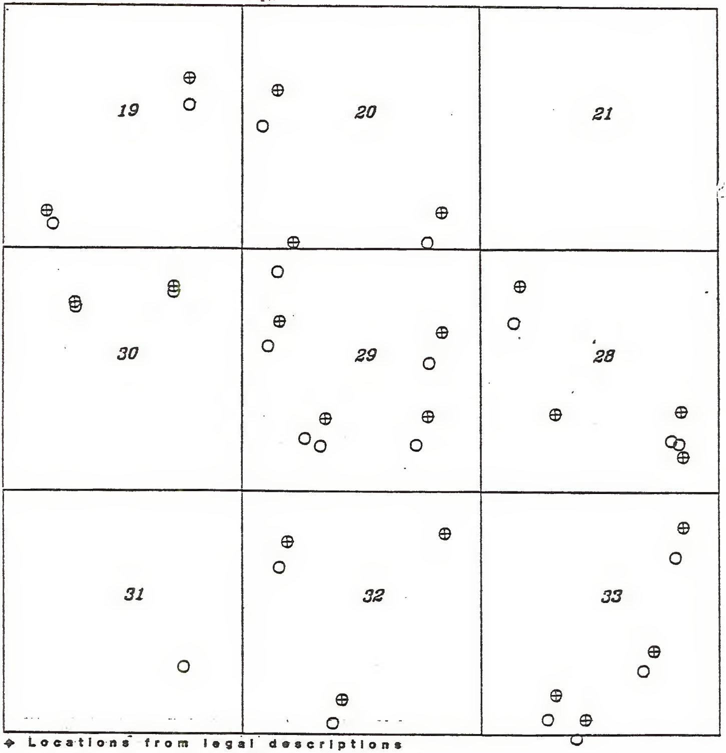
Using macros to improve the user interface demonstrated the need for a more simplified user-machine interface for LIS capabilities if they were implemented in field offices. Additionally, Resource Area personnel expressed the need to have flexibility in using the system, a capability that the macros did not provide. The macros were written in the language of a nonstandard operating system and cannot be directly transferred to computers other than the DG.

The quality of data was cited as a major, potential problem. Some of the data were inaccurate, inconsistent, or simply not available. PI data, especially, were inaccurate with problems of internal consistency. Geographic locations of wells proved to be inconsistent when retrieved directly from the latitude/longitude coordinates computed with legal descriptions. Figure 12 shows the locational differences of wells that were common throughout the PI data file. Note that latitude/longitude locations tend to be systematically displaced to the southwest. By comparing these locations with well maps derived from photogrammetric placement, the coordinates generated from legal descriptions (footage calls from the section line) were determined to be more accurate. Accuracy associated with these locations, however, resulted from highly accurate land surveys throughout the study area. This may not be the case in other study areas. Additionally, all wells did not have legal descriptions, creating an incomplete locational data base when only legal descriptions were used.

Other concerns about data became apparent when plotting the maps derived from Case Recordation legal descriptions. One active lease was not available in the data base. Resource Area personnel emphasized the need to have a complete data base that is accurate and up-to-date.

Different sources of coordinate data also revealed differences in the locations of section boundaries. The locations of digitized coordinates and coordinates computed with PCCS were compared. Although the two sources compared favorably for most of the study area, isolated cases revealed significant differences. Figure 13 shows an example of locational differences between the two sources in T22N, R6W. The coordinates produced with PCCS were estimated to be more accurate than digitized coordinates, given their original sources and systematic errors propagated through the digitizing process. The generic township coordinates were least accurate and were not used for the comparison, but proved useful for testing software and producing sample products.

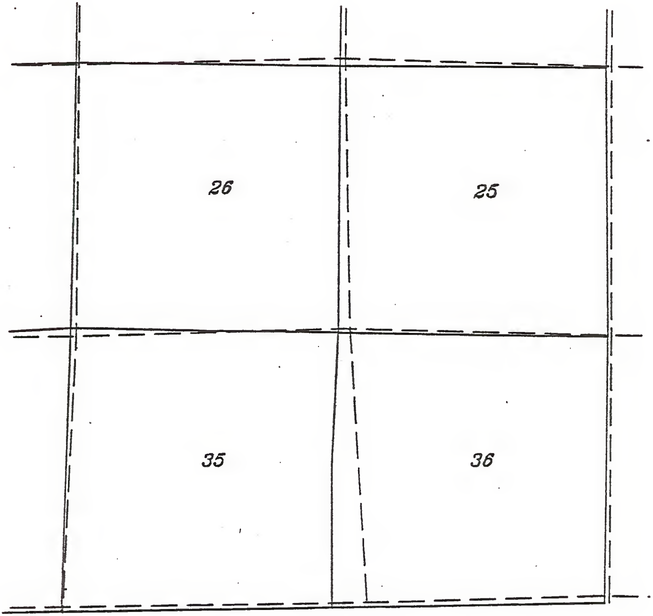
Additionally, USGS 7 1/2-minute quads seldom portray the location of any coordinates in the land net, other than section corners. Survey data include all coordinates that affect the location of section boundaries. Therefore, section boundaries that change direction at a quarter corner are seldom captured in the process of digitizing, but are accounted for with PCCS. Figure 14 displays the potential kinds of differences that would result from this kind of situation.



⊕ Locations from legal descriptions

o Locations from Latitude, Longitude

Figure 12 Example of Locational Variances on PI Data



——— = PCCS

– – – – = USGS Quad

Figure 13 Locational Differences in Coordinates computed with PCCS and Digitized from a 7 1/2 minute quad

(from USGS quad)

(from PCCS)

Figure 14 Examples of Locational Differences between Coordinate Sources

(scales differ)

C. RECOMMENDATIONS

Since the capabilities demonstrated and used as part of this demonstration are, for the most part, available on existing MOSS/ADS-based GIS systems in the Bureau, the Bureau should continue to use these systems to assist with accomplishing field tasks. The macros developed for the Redline demonstrated the potential for improved user-machine interface of current GIS capabilities. However, the Bureau should not pursue the development of additional macros on DG equipment. The Tektronix terminal greatly improved the user's ability to examine and display graphic data and enhanced the user interface to the system. Existing graphics terminals currently being used for GIS should be examined for replacement, since many issues, such as the amount of time required to plot maps, can more easily be addressed by hardware than software.

Data and the management of data also should be addressed. Applications of any system depend on the data. Attempts should be made to improve the quality of existing data and to standardize coding, accuracy, and transfer procedures. Serious consideration needs to be given to PI data and to Case Recordation. Capabilities for updating and quality control were specified as needed improvements. To enhance the capability, the Bureau should examine the potential interim applications of an RDBMS.

D. SUMMARY

Farmington Resource Area personnel, with help from the NMSO, used the existing system primarily to process APDs. Work was conducted on a Tektronix 4111 graphics terminal which offered better capabilities than other terminals currently being used in BLM. In addition, macros were written, which simplified the processing of data and eliminated the need for extensive training. Although the macros were easy to use, they did not offer enough flexibility nor the capabilities to update APDs. This indicates that more macros or programs need to be developed, further promoting the need for an RDBMS.

Again, as cited in previous chapters, incomplete or inaccurate data surfaced as a major problem.

Chapter VI

APPLICABILITY TO THE BUREAU

The integration of the coordinate, record, and resource data, using the Redline functions, has applicability in many Bureau offices. Currently, the integration of these data types requires manual processing or duplicating digital files by table-digitizing PLSS and ALMRS themes. Both processes are labor-intensive and represent a significant commitment of resources. The ability to integrate these data in an analytical environment is a substantial benefit because of decreased labor requirements. However, the Redline has significant limitations which will be discussed later.

A. CAPABILITIES

The Redline has the same analytical capabilities of the MOSS system, but also contains several enhanced capabilities. First, because of the macros developed, the Redline is easier to use than MOSS. Second, some records can now be graphically displayed to include legal description and limited case data. Third, the graphics displayed are tied to points on the earth through geocoordinate data.

With the Redline, the Bureau is capable of developing a single data base containing record and resource information that tie to positions on the earth in an automated manner. Since digitizing is avoided, significant amounts of time and money are saved in creating and maintaining the data base. The Bureauwide applicability of a system that allows for the efficient use of heterogenous, but spatially related data are readily apparent. The typical resource specialists in the Bureau today spend considerably less time in the field than those in previous years. These specialists are now required to spend more time analyzing data in an office for Resource Management Planning, Environmental Assessments, Environmental Impact Statements, and special permits. A system that would allow quicker, more accurate analysis would allow the resource specialists more time in the field and result in more effective management of the public lands.

B. LIMITATIONS

The Redline capabilities have significant limitations. Because the Redline did not contain an RDBMS, the system had limited flexibility in analyzing alphanumeric data. Much of the data used for analysis, such as resource values or case data, was in an alphanumeric format. Currently, data must be stored in attribute files which are cumbersome to use. Without an RDBMS, along with a data base administrator, selection and retrieval of this data proved extremely difficult and time-consuming. The results are limited ability to analyze data and the necessity for manual manipulation of cases.

A second limitation of the Redline is that only one data structure is accepted by the system. All data fields must be of the same fixed length. This caused significant problems in loading data into the system because automated data fields come in various lengths. Eight of the 10 months spent on the project were devoted to identifying data requirements and converting the data files to a standard format. If an RDBMS had been available, the conversion of data would have been much easier and quicker.

C. BENEFITS

The Redline has demonstrated the benefits of automation. In one test case, the performance of the Redline was compared to the performance of the Bureau's present digitizing system. The findings concluded that the Redline saved 90 percent of the time required for capturing data themes under the present digitizing system (see Appendix D for a detailed time table). However, this test assumed that all of the required data were available and did not include time needed to convert the various alphanumeric data into a standard format.

The results of this test would not be valid in all Bureau offices. Only a limited number of States have all of the ALMRS-GIS data necessary to run the Redline. But, more importantly, each office would need to convert much of its data to a standard format, which would be laborious.

D. CONVERSION OF THE REDLINE TO PRIME COMPUTERS

Converting the Redline process, which now runs on DG computer equipment, to Prime computer equipment must take place in the following five areas: (1) data conversion, (2) standard processes, (3) specialized Redline processes, (4) user interface, and (5) data transfer. Conversion to the Hewlett Packard (HP) 9000 series computer is also addressed since States are using this equipment for mapping and analysis purposes, and the proposed Blueline will be demonstrated on it.

1. Data Conversion.

Most of the work during this process involved gathering the necessary data and ensuring a data conversion format readable by the Redline. The same basic conversion process was used on each data source. This entailed writing software macros in DG's CLI language. Some data sources required one macro; some three. The CLI macros were written to exercise DG's SORT/MERGE utility, which reads one kind of format, massages it according to user-defined criteria, and provides output in either the same or a different format. The data conversion macros written all use the SORT/MERGE utility in one form or another.

Converting these macros to either the Prime or HP can take two avenues: using the same basic conversion set-up or developing new software. By using the same basic set-up, macros can be written on the Prime SORT/MERGE utilities. This will require searching out the existing SORT/MERGE capabilities on the Prime and aligning them with those used on the DG to determine whether data can be converted on the Prime.

New macros will have to be written on the Prime in Primex, a UNIX shell which allows users of Prime computers to emulate the UNIX operating environment. The Prime's main operating system has Command Programming Language (CPL) which is like DG's CLI. Although macros can be written in CPL, they would not be portable. Writing them in Primex will allow them to be easily transported to the HP, assuming the HP has a SORT/MERGE utility which can convert the data. This will be addressed in the same manner as the Prime.

Approximately 10 macros can be used to convert the data on the DG. Depending on how the Prime or HP SORT/MERGE utility works, this number may vary. The Primex/UNIX at the SC is more well-known than CPL, which is another reason for writing macros in Primex.

Converting the data conversion macros to the Prime and developing the same functionality as exists on the DG is estimated as follows (knowledge of UNIX assumed):

- One specialist: 220 hours

The other avenue is to develop new software using a high-level language such as "C" or FORTRAN 77. Since the functionality of what needs to be done to the different data sources is now known, a program or series of programming modules can be written to facilitate them. This accommodates the issue of portability. Writing the program(s) in a portable language will free the process from being tied to some computer's SORT/MERGE utility; only the program(s) will have to be converted. Depending on the computer, this may require rewriting the macros. Rewriting data conversion macros in a high-level language would take about as much time as writing new macros.

Before either avenue can be taken, each existing macro must be fully documented. This will ensure at least the basic knowledge transfer required to duplicate the data conversion processes.

2. Standard Processes.

ADS, MOSS, and PCCS are the standard processes that must be converted. The Bureau currently has a contract with Environmental Systems Research Institute (ESRI) to convert ADS and MOSS to the Prime. This task is on schedule, and the source code is set to be delivered the first week in April 1987.

The Redline process uses the current release (2/87) of MOSS. As the (ESRI) MOSS source code is delivered, the changes, enhancements, and fixes must be incorporated. The schedule for starting this is late May. About 160 hours will be needed to include testing.

The PCCS program is currently being converted to the Prime by Bill Ball (SC). This schedule is ahead of the MOSS schedule.

The Redline uses changes to ADS that are not being converted by Environmental Systems Research, Inc. (ESRI). Conversion will entail putting those changes into ADS after it is delivered by ESRI. The schedule for this is concurrent with the MOSS schedule: start May, finish June.

Since the conversion of standard processes is already ongoing, only the schedule for converting the Redline to the Prime could be an impact. The earliest the Redline could be working on the Prime would be late June or early July 1987.

3. Specialized Processes.

The following five processes will need to be converted:

- GGWL
- Parcel Generator
- PCCS2ADS
- PGFORMAT
- INTGGWL

Each of these programs was written specifically for the Redline process. This does not mean they could not be used elsewhere, but each is required for the Redline. Each already exists in FORTRAN 77, but on the DG.

Converting DG FORTRAN 77 to Prime 77 is not as straightforward as it would initially seem. Since the Prime does some things differently in its FORTRAN 77, conversion may be slower than expected: approximately 80 hours per module, converted and tested. This would involve 400 hours for one specialist, or 1 to 2 months of work to convert the modules as they are.

Comments arising from this evaluation show that additional time and resources must be considered to bring several of the programs up to a more functional level. These include PCCS2ADS and Parcel Generator.

Parcel Generator needs to have some enhancements that will further improve its usability for the Redline. PCCS2ADS needs considerable work to improve several areas that are not working correctly. These include changes in how it windows for the border, how it handles attributes and attribute placement, how it accepts lines not on section or township lines, and strict format problems. An estimated 160 hours will be required to improve these two programs.

To properly convert all five programs would take about 560 hours.

4. User Interface.

The Redline seems to be one program, but in reality is a series of DG CLI macros. Some of these macros are wired together (i.e., they can call or execute each other); other macros are run individually.

The group of macros that are wired together form what the average user would see as one program. These macros bring up menus and receive user input, bring up pre-developed graphics, or call up another macro.

The stand-alone macros are used to create the "predefined" graphics. These macros run on MOSS and ADS.

Currently, about 50 of these "user interface" macros are written in DG CLI. As mentioned earlier, converting DG CLI to the Prime would best be done with two avenues in mind: converting from CLI to Primex shells and writing a high-level language program to do the same thing. A pro for macros is that the current DG set-up could be followed and save time; a con is the limitation of the Primex shell language. A pro for the new programming is that better functionality can be incorporated; a con for the new programming

is the rethinking and time involved to develop it, affecting the schedules for bringing up the Redline on the Prime. Estimates for these are as follows:

- Macro: one specialist: 16 hours/macro = 800 hours
- New Programming: one specialist: 800 hours

5. Data Transfer.

Concurrent to this evaluation but affecting the Redline scheduling is the process of transferring existing and archived data (maps/attributes) from the DG environment to the Prime. A task order is currently being developed to facilitate this. It will consist of the developed tools (programs), procedures, and communication requirements that any GIS site can use and follow.

The hours and schedules are not completely developed, but a workable data transfer mechanism is scheduled to be in place by July 1, 1987. This flows with other schedules as mentioned in other sections.

About 1,600 hours will be needed to convert the system. Less time would be needed if compatibility existed. Macros will have to be totally rewritten and, in some cases, rethought. This means that conversion would take almost as long (in hours) as development. However, more than one specialist could be used. The estimate is one specialist converting the data conversion macros, one converting the specialized programs, and one converting the user interface macros.

Various schedules that are resource-driven are shown in Appendix D.

E. RECOMMENDATIONS

The evaluation team recommends that some applications from the Redline should be converted from DGs to Primes because...

- A majority of the States will have Primes within the next several years;
- The Prime contract may be modified to include an RDBMS, which was the major limitation of the Redline;
- Many of the Redline utilities are being converted to Prime (MOSS, Parcel Generator, etc.) so they can be used on the Blueline;
- By the time the conversion is ready for implementation, results from the Blueline should be available. This would enable the Bureau to decide what best meets Interior needs without causing undue delays.

The evaluation team further recommends the following:

- The special macros should be the last items converted because they would not be necessary if an RDBMS could be purchased;
- The Redline should be maintained on only one set of hardware, the Prime, because resources for maintaining it on both sets of hardware are unavailable;

- The Bureau must start developing standards for all of its automated data immediately. Without standards, implementation of automated systems will be extremely complex and time-consuming.

In addition, the Bureau should have data base administrators at the Washington Office and State Office levels. Those at the State Office level would work with the Washington Office in performing the following duties:

- Maintain and be solely responsible for the integrity of all user and system data files;
- Assist in establishing data standards that will meet user requirements;
- Validate and ensure quality control to enforce data standards for all data bases;
- Implement and verify data reformatting and conversion programs for data exchange;
- Provide training on data standards and data base administration;
- Seek new sources and obtain data from other sources of information that could meet user requirements;
- Coordinate data exchange efforts among BLM offices and between the Bureau and other agencies;
- Generate data base activity and status reports;
- Ensure appropriate data archiving procedures are used and archived files are stored properly;
- Coordinate data base construction activities;
- Verify that data restoration and backup procedures are carried out on a scheduled basis;
- Recommend and ensure that all users are implementing good data management practices for all projects;
- Maintain historical records for data base construction and exchange activities.

APPENDIX A: BUREAU MANAGEMENT TEAM

Robert F. Burford	Director
David O'Neal	Associate Director
Elizabeth Morris	Coordinator, Management by Objectives
Hank Smith	Deputy Director, Lands & Renewable Resources
Robert Lawton	Deputy Director, Energy & Mineral Resources
James Parker	Deputy Director
Thomas Allen	Deputy Director, Management Services
Michael Penfold	State Director, Alaska
Dean Bibles	State Director, Arizona
Jack Wilson	Director, BIFC
Ed Hastey	State Director, California
Neil Morck	State Director, Colorado
Robert Moore	Director, Service Center
Curt Jones	State Director, Eastern States
Delmar Vail	State Director, Idaho
Dean Stepanek	State Director, Montana
Edward Spang	State Director, Nevada
Larry Woodard	State Director, New Mexico
William Lusher	State Director, Oregon
Roland Robison	State Director, Utah
Hillary Oden	State Director, Wyoming

APPENDIX B: SOURCES OF DOCUMENTATION

List of Supporting Documentation

1. MOSS Users Manual
2. ADS Users Manual
3. Redline Macros for Farmington Demonstration
4. PCCS Users Guide
5. Automated Resource Requirements Study
6. Parcel Generator Users Guide
7. Tektronix 4111 Users Guide
8. SORT/MERGE Users Manual
9. SED Users Manual
10. AOS Users Manual

Appendix C: COLLECTION OF SURVEY COORDINATE DATA

CADASTRAL CONTROL SURVEY

FOR

FARMINGTON DEMONSTRATION PROJECT

UNAPPROVED
Subject to Correction
And Approval

Objectives

The primary objectives are to establish geographic coordinates on selected Public Land Survey System (PLSS) corners using the three available methods; conventional survey, Doppler satellite and Global Positioning System (GPS) and to compare and evaluate these methods.

Location

The F.D.P. is located in northwestern New Mexico, about forty miles northwest of the Village of Cuba.

Size

The F.D.P. consists of a block of nine Tps. 22, 23, 24 N., Rs. 6, 7, 8, W., N.M.P.M., encompassing about 320 square miles.

Access

The main access to the F.D.P. is by State Highway No. 44. Within the project is an extensive network of improved dirt roads. Most of the selected P.L.S.S. corners are accessible by road, with a few only a short walk.

Topography

The topography consists of high mesa tops with deep irregular canyons in the northern portion and broken low lands with vast open terrain in the southern portion. The vegetation varies from native grasses and sage brush in the southern portion to juniper and pinon pine, and ranging from scattered to moderate stands in the northern portion.

Transportation/Time

Transportation used for this project was with four wheel drive vehicles (3). The time involved was a major factor. From the Village of Cuba, NM, 45 minutes to 1 1/2 hours was spent traveling to the job site. Travel within the project and getting to and from stations, ranged from 1/2 hour to 1 1/2 hours. A considerable amount of time was spent in transit.

Equipment

All special instrumentation was borrowed from D.S.C. cache and included: 1 Wild T-2 theodolite, 2 tripods with adaptors and tribracks, 2 Microfix microwave EDM's, 1 HP-3808A infrared EDM, 2 psychrometers and 2 barometers. Three trucks were used and furnished by this office along with all the normal survey gear. Items that were purchased included 1 fence post driver, 2 umbrellas and about 10 bags of concrete.

Operations

Prior to the conventional survey work, a Doppler crew from the Colorado State Office was to establish geographic coordinates on the 16 selected PLSS corners, followed by a Global Positioning System (GPS) crew from U.S.G.S.

At the request of the GPS crew, the New Mexico State Office conducted an extensive reconnaissance of the project area to select the most suitable PLSS corners, the available geodetic control and a very concise "how to reach" instructions and descriptions. A copy of the reconnaissance report is attached.

The 16 selected PLSS corners were all to be township corners except where accessibility limited the use of the satellite systems. In these cases, corners nearest the desired township corner were selected and termed eccentric positions.

The Doppler crew from Colorado began its work on the Farmington Demonstration Project on July 7, 1986 and finished the field work in 9 days. Their report is attached.

The geographic coordinates obtained from the Doppler system on the 16 selected PLSS corners were sent to the Oregon State Office along with the survey plats for the nine townships. Oregon used the Bureaus PCCS program and computed geographic coordinates for all the PLSS corners in the project. During these calculations a problem with closures on the plat of the 1950 resurvey in T. 22 N., R. 8 W showed up. Four of the PLSS corners in this township were identified to be included in the conventional survey work for verification. Attached is a copy of the report from the Oregon State Office.

The GPS crew was scheduled to commence work following the Doppler crew but could not meet the schedule due to equipment procurement problems.

The New Mexico Cadastral Control Survey crew selected 8 of the designated 16 PLSS corners positioned by the Doppler crew to establish geographic coordinates on using a conventional survey approach. These 8 PLSS corners were selected to give a good coverage of the project and for a geographical position comparison to the positions established by the satellite systems in relation to and the local geodetic network.

In performing the field work all intermediate cadastral control stations were monumented. These stations were selected to be of general use for any future work done in the area. This added 20 more monumented positions identified by geographic coordinates. Field measurements adhered to N.G.S. 2nd order class two standards for traversing. Ten N.G.S. 1st and 2nd order triangulation stations were incorporated and a double run method of traversing used.

All computations except for the final adjustment were completed at the end of the field work. Three days were spent at DSC using their computers for the final adjustment. Field work began August 4, 1986 and was completed September 11, 1986. The New Mexico State Office Cadastral field crews worked a 40 hour week. The crew consisted of 5 people with experience limited to one.

Cost

The total cost for the conventional geodetic work on the Farmington Demonstration Project is broken down into three categories:

Wages:	$11,375.53 (Includes field, office and surcharges)
Travel:	3,864.91
Vehicles:	2,003.96
Total:	$17,244.40

The total cost for the reconnaissance was $5,717.52 and was performed at the request of the GPS crew. Both the Doppler crew and the Conventional crew benefitted from this, however in the layout phase of the conventional work, extensive additional reconnaissance had to be performed.

Cost/Point

12 PLSS positions at $1,437.00 per point.

32 total positions at $539.00 per point.

Advantages

The conventional approach for acquiring geographic positions is best suited to special circumstances, such as terrain and areas where interference prohibits satellite systems. The conventional methods leave a byproduct of additional monumented geographic positions that can be of future use.

Disadvantages

Conventional methods are time consuming, costly and there is a lack of experienced field personnel within the Bureau.

Summary

Per point cost data can be misleading or easily misinterpreted because they ignore the dynamic nature of geodetic positioning technology costs. The positioning costs for any situation are totally dependent upon the specifics associated with the particular situation being analyzed. Additionally, it must be understood that more than one positioning technology may be used to satisfy any given positioning requirement. Situations do exist for which Doppler satellite, G.P.S. and conventional survey methods are applicable positioning tools.

Original Survey

Based on past experience of four years operating Doppler satellite systems in the Colorado State Office, using the normal configuration of receivers, breakdowns, types of projects, crew size and terrain variations, one can expect the cost per point to fall within the range of $500.00 to $1,000.00.

Because of the density of coal, oil and gas activities in the Farmington Demonstration Project area and the use of this project as a training and test grounds, the decision was made to monument the intermediate stations. The cost per point of the 12 PLSS corners identified would be about $1,200.00 per point or a savings of about $3,000.00 from the total cost.

The G.P.S. approach to obtaining geographic coordinates appears to be the most effective method, however it is still a relative new technology and needs to be tested and evaluated. In the future, I hope to have the opportunity to test the G.P.S. on the Farmington Demonstration Project and finish this report with a comparison of all the available positioning tools.

The following is a comparision of the geographic coordinates from the two methods used so far on the Farmington Demonstration Project.

	DOPPLER	CONVENTIONAL	Diff in "	Diff. in ft.
COR-1	36° 05' 09.737"	36° 05' 09.736"	.001"	0.1 ft.
	107° 24' 44.117"	107° 24' 44.123"	.006"	0.5 ft.
	2156.9 m	2158..0 m		3.7 ft.
COR-3	36° 05' 18.182"	36° 05' 18.187"	.005"	0.5 ft.
	107° 37' 32.056"	107° 37' 32.045"	.011"	0.9 ft.
	2014.7 m	2014.4 m		0.9 ft.
COR-5	36° 10' 33.966"	36° 10' 33.964"	.003"	0.3 ft.
	107° 43' 51.129"	107° 43' 51.132"	.003"	0.2 ft.
	2013.7 m	2014.2 m		1.7 ft.
COR-6	36° 10' 33.689"	36° 10' 33.687"	.002"	0.2 ft.
	107° 37' 25.531"	107° 37' 25.522"	.010"	0.8 ft.
	2096.7 m	2097.4 m		2.2 ft.
COR-7	36° 10' 32.702"	36° 10' 32.700"	.002"	0.2 ft.
	107° 31' 01.079"	107° 31' 01.096"	.017"	1.3 ft.
	2174.4 m	2174.6 m		0.8 ft.
COR-10	36° 15' 39.308"	36° 15' 39.296"	.012"	1.2 ft.
	107° 31' 38.849"	107° 31' 38.858"	.009"	0.7 ft.
	2061.0 m	2060.4 m		2.1 ft.

COR-13	36° 21' 01.639"	36° 21' 01.620"	.019"	2.0 ft.
	107° 43' 51.690"	107° 43' 51.685"	.005"	0.4 ft.
	2030.9 m	2030.7 m		0.8 ft.
COR-15	36° 20' 59.250"	36° 20' 59.247"	.003"	0.3 ft.
	107° 31' 03.393"	107° 31' 03.399"	.006"	0.5 ft.
	2005.7 m	2005.5 m		0.5 ft.

7-12-87

IN REPLY REFER TO:

CO-942
9600

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
COLORADO STATE OFFICE
2850 YOUNGFIELD STREET
LAKEWOOD, COLORADO 80215

JAN 08 1987

Memorandum

To: Chief, Branch of Cadastral Survey
Chief, Office Engineering Section

From: Geodesist

Subject: Farmington Demonstration Project, MX1502 Satellite Survey Report

On July 7, 1986, the Special Survey Unit control crew traveled from Colorado to New Mexico to establish geographic coordinates on 16 Public Land Survey System (PLSS) corners. The 16 township corners are 40 miles southeast of Farmington in gentle terrain where they encompass 9 Townships (324 sq. miles). As a valuable by-product 16 additional adjoining townships were controlled to a lesser degree by the equipment laden crew.

The crew utilized 5 Magnavox MX1502 satellite Doppler units in conjunction with 12 automobile batteries (12 Volt) and 4 battery chargers. The equipment required for one MX1502 setup weighs in excess of 150 pounds. One of the five units was considered a backup, even though it was used for production. Two of the MX1502 Geoceivers were requested and received from the Alaska State Office with the Farmington Project is mind. Earlier, Colorado requested four Doppler units from the equipment cache for use this field season, but were granted only three units due to the increased demand for geodetic control from other states. The crew had 3 four-wheel drive vehicles with the third planned as a backup. During the project, a new Ford Bronco went down twice with electrical problems and the use of the backup saved this phase of the project time and money. The control crew consisted of four people, a GS-9 Party Chief, with 8 months of intense Doppler experience, a GS-5 Survey Aid, with no survey experience and two GS-4 Survey Aids, each with three field seasons of cadastral experience. As Unit Chief I observed and participated, which brought the crew size to five people. This influenced the overall cost and time requirements.

The total cost of this phase of the Farmington Demonstration Project is broken down into three categories:

Wages (Includes field, field overtime, office and surcharges)	$5,095
Travel	1,837
Vehicles	300
Total	7,232
Budget	7,000
Over Budget	232

Note: The costs for the Doppler units were not considered. At current market rates an MX1502 can be leased from Magnavox for more than 90 days at $165.00 per day.

The time required to complete this phase of the project is broken down into three categories:

Field	09 days
Travel to and from Farmington	01 day
(Note: 10 days without a break)	
Office	03 days
Total	13 days

To complement these statistics of time and cost were five special circumstances which were existent only for this Demonstration Project.

The field work for the project was closely scheduled and the site was ideally located for MX1502 work; therefore, a number of situations involving cost and time do not truly reflect a normal Doppler control project dealing with one township.

Special Circumstances:

1. Historically, for a one township job, only one master triangulation station was occupied even though two tri-stations should have been occupied to provide sufficient redundancy to the resulting geographic coordinates at slave stations. In the past, two master tri-stations were occupied for larger projects. In the case of the Farmington Demonstration the planners wanted the field work to resemble the historical small control job, and hence, one master tri-station was used resulting in lower costs and decreased redundancy.

2. The New Mexico State Office (NMSO) planned and organized the project, much to our benefit. They published their plan under the title "Control Survey Plan GPS, Farmington Demonstration Project" dated June 1986. This published plan and associated materials supported us with such items as a project diagram, preliminary geographic coordinates, township corner descriptions, triangulation station descriptions, U.S.G.S Quad Maps, N.G.S Horizontal Control Data Sheets and BLM 1:100,000 surface management status quad maps. Each field station or corner and its alternate were reconnoitered, evaluated and directions to the point published. This type of preparation, completed by someone else, goes well beyond that found in a "normal" control project. In addition, NMSO project leaders met with the control crew in the field to review the Doppler portion of the project.

3. The gentle topography and good vehicle access improved the control crew's normal efficiency. The lack of timber and the open terrain vastly improved the MX1502's ability to gather satellite pass data. Normally in Colorado a Doppler requires from three to five days over a corner to collect a sufficient number of three dimensional passes. At the Demonstration Project two days were required. The short two day gathering period at an occupied corner was also influenced by satellite geometry, which was exceptional during this time period, with few satellite passes in conflict.

4. The control crew had five MX1502's at their disposal, with Alaska to thank for two of them. The normal crew has only three MX1502's.

5. The last special circumstance which takes the Demonstration Project away from the normal situation is the fact that this job was performed straight through in ten days without breaks for the crew. MX1502 Geoceivers are not efficient when not in use. Two crews and one set of Dopplers may be the ideal situation. Each MX1502, once initialized, should remain powered-up during short periods of non-use and a twice a day check should be made. If a machine loses power it must be reinitialized and its occilator requires 24 to 48 hours to stabilize. Problems of this type were avoided in Farmington by using overtime and the scheduling of crew time off at either end of the job. Any cost analysis the Doppler phase of the project should be evaluated in light of these five special circumstances.

Cost Analysis:

Scenario Number 1

The Job as Accomplished, Sixteen PLSS Corners Controlled

a. Five MX1502 Geoceivers (no rental fee)
    (1) One Master
    (2) Four Slaves

b. Ten days to complete field work
    (1) No crew breaks
    (2) 48 hours per station for data collection
    (3) 1 Master and 4 Slaves
    (4) Reconnaissance by someone else
    (5) Favorable topography/timber
    (6) Favorable satellite geometry

$450 per point

Scenario No. 2

Same as Number 1, except add rental cost of $165.00 per day per MX1502

$970 per point

Scenario Number 3

Same as Number 1, except utilizing two Master Stations which results in 14 days to do field work

$600 per point estimated

Scenario Number 4

Same as Number 1 except utilizing three MX1502s

a. One Master
b. Two Slaves
c. 18 days (no breaks)

<u>$750 per point estimated</u>

Scenario Number 5

Utilizing three MX1502's with unfavorable topography/timber

a. Three MX1502 Geoceivers
   (1) One Master
   (1) Two Slaves

b. 34 days to do field work
   (1) No crew breaks
   (2) 96 hours per station for data collection
   (3) Reconnaissance by crew
   (4) Unfavorable topography/timber
   (5) Unfavorable satellite geometry

<u>$1,350 per point estimated</u>

The preceeding cost estimates were presented to stimulate thought with respect to satellite receiving equipment efficiency at the Farmington Demonstration Project with its major variations from the norm. It is not intended that these cost figures be used out of contex. The actual geographic coordinates of the 16 PLSS corners were transmitted to NMSO in a memorandum dated July 30, 1986, and therefore, do not appear within this memorandum.

Carl Nagy

CONTROL SURVEY PLAN

GPS

FARMINGTON DEMONSTRATION PROJECT

Prepared By: BLM, NMSO
Cadastral Surveys
Santa Fe, New Mexico
June 1986

TABLE OF CONTENTS

1. Introduction/Requirements

The GPS survey of the 16 Township corners of the Farmington Demonstration Project is to provide high accuracy geodetic coordinates which will be the control framework for the whole project, and will be the standard for determining the accuracy of other surveying instruments and techniques used. Also, costs and production rate data will be determined for comparison with other methods.

Since the results must be accurate and reliable, it is required that the survey be performed to meet second-order, class II horizontal control standards. The unadjusted relative position data should be provided so that loop closures can be computed. All position coordinates must be in the 1927 NAD system.

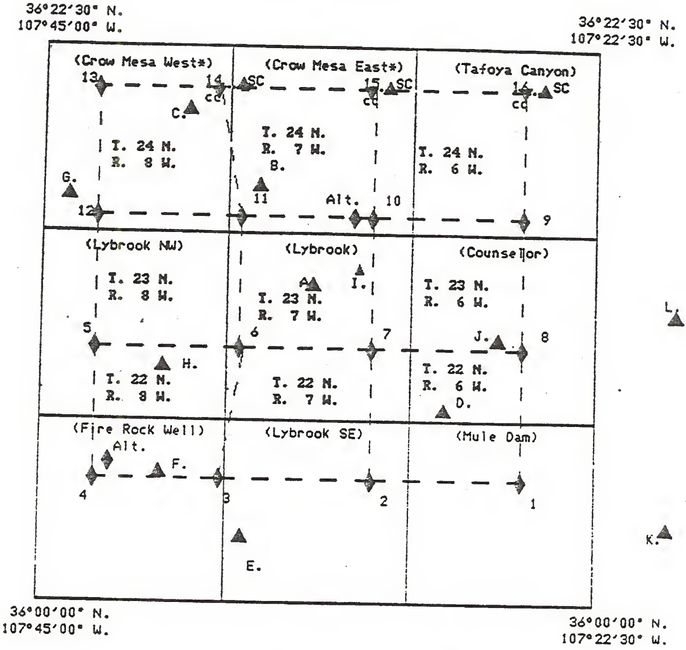
The final GPS coordinate data results should be available as soon as possible after August 15, 1986. The GPS vertical coordinates will probably be useful for geodetic studies, but are not a requirement for this project.

2. Discussion

The Farmington Demonstration Project is located in northwest New Mexico, on high valley-mesa type terrain, with deep canyons along the northern edge. Vegetation consists of sage and grasses, with timber primarily juniper and pinon pine, ranging from scattered to moderate stands. The road-net is extensive, with almost all township corners and triangulation stations attainable by roads or 2-track jeep trails. A few stations and corners will require short hikes.

The township corners are located where placed by the land surveys, without consideration to topography or vegetation. Because of this, the GPS survey party should be prepared for any special situations. A twenty foot mast will be beneficial for a few stations. Eccentric occupations should be avoided if at all possible.

PROJECT DIAGRAM



—— 7.5' topographic quadrangle maps
* provisional edition, 1985

---- Township Lines

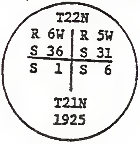
▲ Tri-stations

A. Lybrooks	G. Nageezi
B. Brooks	H. Akin
C. Crow	I. Post
D. Lock	J. Stone
E. Union	K. Topper
F. Sargent	L. Apache

Preliminary Coordinates

Tp. Corner	Scaled: 7.5 Quad	(N) Latitude	(W) Longitude	(FT.) Elevation
1	Mule Dam	36° 05' 10"	107° 24' 45"	7073
2	Lybrook SE	36° 05' 16"	107° 31' 09"	6913
3	Firerock Well	36° 05' 18"	107° 37' 32"	6603
4	" "	36° 05" 20"	107° 43' 56"	6530
Altern. 4	" "	36° 06' 13"	107° 42' 48"	6607
5	Lybrook NW	36° 10' 34"	107° 43' 51"	6603
6	Lybrook	36° 10' 34"	107° 37' 26"	6874
7	"	36° 10' 32"	107° 31' 01"	7129
8	Counselor	36° 10' 26"	107° 24' 38"	6915
9	Tafoya Canyon	36° 15' 44"	107° 24' 38"	6760
10	Crow Mesa East	36° 15' 38"	107° 31' 08"	6940
Altern. 10	" " "	36° 15' 39"	107° 31' 39"	6740
11	" " "	36° 15' 48"	107° 37' 26"	6925
12	Crow Mesa West	36° 15' 48"	107° 43' 54"	6927
13	" " "	36° 21' 02"	107° 43' 52"	6660
14 CC	" " "	36° 20' 59"	107° 37' 32"	7080
14 SC	Crow Mesa East	36° 20' 59"	107° 37' 30"	7090
15 CC	" " "	36° 20' 58"	107° 31' 04"	6580
15 SC	" " "	36° 20' 58"	107° 31' 02"	6570
16 CC	Tafoya Canyon	36° 20' 59"	107° 24' 36"	6670
16 SC	" "	36° 20' 59"	107° 24' 34"	6650

CORNER NO. 1
Tps. 21 and 22 N., Rs. 5 and 6 W.



3" I.P. w/B.C.
Proj. 12" above gnd.
Located SW of fence post corner, lines N. and E., in open valley, on NE side of bend in road. (SE-E), No timber; no mast necessary; very slight verticals (2-4°), good window.

To Reach Cor. No. 1

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

Head ESE on Hwy. 44 for 5.90 miles to the dirt road heading S. out of Counselor (turn right), proceed S. on this main dirt road for 4.6 miles to a major junction, bear left (SE) on this main dirt road and proceed for 5.65 miles to a junction with another dirt road, bear left (SE) for .15 miles to station on left (at fence corner).

CORNER NO. 2
Tps. 21 and 22 N., Rs. 6 and 7 W.

T22N

R 7W	R 6W
S 36	S 31
S 1	S 6

T21N
1948

3" I.P. w/B.C.
Proj. 10" above gnd.
located on S. edge of small rise, in open sage/grass, no timber, no mast necessary, slight verticals (2°), good window.

To Reach Cor. No. 2

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

Head ESE on Hwy. 44 for 5.90 miles to the dirt road heading S. out of Counselor (turn right), proceed S. on this main dirt road for 4.6 miles to a major junction, continue straight on main dirt road, heading SW for another 6.0 miles to a point SE 500' from station; cut in off main road at waterbar, and faint 2-track trail, past powerline to station.

CORNER NO. 3
Tps. 21 and 22 N., Rs. 7 and 8 W.

T22N
R 8W | R 7W
S 36 | S 31
S 1 | S 6
T21N
1947

3" I.P. w/B.C.
Proj. 4" above gnd.; mnd. stone to SW;
located in N-S fenceline, 38' N. of intersection
W/E-W fenceline; W. of sandy wash, in open sage.

No timber; no mast necessary, very slight verticals (4°) to W and SW., <u>good window</u>.

To Reach Cor. No. 3

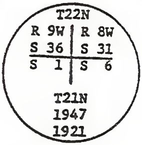
From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

Head ESE on Hwy. 44 for 5.90 miles to the dirt road leading S. out of Counselor (turn right); proceed S. on this main dirt road for 4.6 miles to a major junction; continue straight on main dirt road, heading SW for another 12.1 miles to a major junction (Radio Tower to E.; signs to Star Lake plant, Pueblo Pintado etc.); turn right heading NW for another 5.15 miles just past cattleguard in E-W fence; turn right (E) on faint jeep trail, staying on N. side of fence; proceed 0.65 miles to top of hill; then head NE at pipeline towards base of hill, around hill, to faint jeep trail, then S. to fence line again, then E. to station (0.55 miles).

"OR"

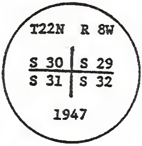
From the Chevron sign, head WNW (then SW) on Hwy. 44 for 9.50 miles to a major road to left (S.), just W. of Hwy. 44, 7-11 store; then head S. on main dirt road for 12.05 miles to N. side of cattleguard in E-W fence (then same directions E. to station).

Tps. 21 and 22 N., Rs. 8 and 9 W.



3" I.P. w/B.C.
proj. 14' above gnd., N. side of juniper pole (6') on NW slope of "Badlands", 500' SSE of small hill, no timber, no mast necessary; 10-15° verticals E., S. and W. <u>fairly good window</u>.

ALTERNATE: Cor. of Secs. 29, 30, 31 and 32, Tp. 22 N., R. 8 W.



2" I.P. w/B.C.
Proj. 6" above gnd. alongside of juniper pole (6') N. of E-W dirt trail road; sparse timber, no mast necessary; verticals O.K. except to N (15°), <u>good window</u>.

To Reach Cor. No. 4

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

Head WNW, there SW, on Hwy. 44 for 9.50 miles to a major road to left (S) just W. of Hwy. 44 7-11 store; thence head S. on main dirt road for 10.45 miles to junction with dirt road to W.; turn right (W.) and proceed for 3.25 miles (staying on this main E-W dirt road - numerous intersections) to the eccentric corner position (cor. of secs. 29, 30, 31 and 32, T. 22 N., R. 8 W.) on right (N.); continue for 1.20 miles WSW on this dirt road, then head SSE cross county towards small hill, 0.35 miles; station is SSE 500'from this point (across wash), (optional roads S. and E (depends on landowner) of station, refer to quads).

CORNER NO. 5

Tps. 22 and 23 N., Rs. 8 and 9 W.

T23N

R 9W	R 8W
S 36	S 31
S 1	S 6

T22N

1947

3" I.P. w/B.C.
proj. 4" above gnd., E. of juniper pole (8')
located 500' due S. of lone butte, on N. side of sandy wash; in open sage, gently rolling terrain. Sparse timber, no mast necessary; slight verticals (10°-15°) to N. and W., good window.

To Reach Cor. No. 5

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

Head WNW, then SW, on Hwy. 44 for 10.20 miles to a major dirt road to left (S); thence head SW for 1.85 miles, bearing left through curve for .10 miles; thence SE for 1.25 miles along dirt road to a junction with dirt road to right (W.); thence head SW for 1.15 miles to junction with powerline road; turn left head SE along powerline road for 1.30 miles (past houses to E.) to a trail road along NW side of sandy wash; turn right (SSW) go 0.20 miles, bear left (S.) and wind around S. side of line butte, .30 miles to station;

"OR"

From junction S. off of Hwy. 44, W. of Hwy 44 7-11 store (desc. cor. No. 4); head S. for 5.20 miles on main dirt road, turn right (W.) along dirt road, proceed 2.00 miles, to curve to right (N.); through curve for .05 miles, thence along powerline road for 1.65 miles to trail road on NW side of wash; turn left and proceed with same directions to station.

CORNER NO. 6

Tps. 22 and 23 N., Rs. 7 and 8 W.

T23N

R 8W	R 7W
S 36	S 31
S 1	S 6

T22N
1947

3" I.P. w/B.C.
proj. 2" above gnd. on top of a small rock knoll (5'x5') in E-W fence line, at base of E. slope. Sparse timber; verticals sharp to N. (10°-15°) and W. (15°-20°); possible mast use; set up may be difficult; possibly a not so good window.

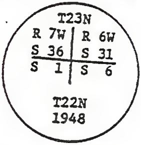
To Reach Cor. No. 6

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

Head WNW, then SW on Hwy. 44 for 9.50 miles to a major road to left (S.), just W. of Hwy. 44 7-11 store; thence head S. on this main dirt road for 5.3 miles to a junction left (E.); turn left, proceed 3.0 miles to a cattleguard at base of hill (N-S fenceline); pass fence and cross country to N. between flags .10 miles to E-W fenceline and station.

CORNER NO. 7

Tps. 22 and 23 N., Rs. 6 and 7 W.



3" I.P. w/B.C.

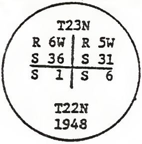
Proj. 6" above gnd. at fence post corner, lines N. and E., located in open sage field; scattered timber N. and W., no mast necessary; very slight verticals (2-4°) good window.

To Reach Cor. No. 7

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

Head ESE on Hwy. 44 for 0.40 miles to a major dirt road to right (S.) (just past mobile homes); turn right and proceed S. for 4.10 miles; bear left (SE) for .15 miles then bear left again (E); (corrals to SW); head ESE on this dirt road (pass cor. of secs. 1, 2, 35, 36 on right - flagged juniper pole) for 1.15 miles to a junction with dirt road to left (N.); turn left, proceed for 0.50 miles (stay on W. side cattleguard and N-S fenceline); turn right (S) and follow 2-track trail road for. 10 miles and station on left (E.) at corner of fences.

CORNER NO. 8
Tps. 22 and 23 N., Rs. 5 and 6 W.



3" I.P. w/B.C.
Proj. 8" above gnd., located in moderate timber (a 20' pinon is 6' SW) verticals slight (5°) except for tree blockage; mast necessary; not a good window due to trees.

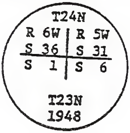
To Reach Cor. No. 8

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

Head ESE on Hwy. 44 for 8.80 miles; just past the Jicarilla Indian Reservation bdy. sign, turn right (S.) on dirt road, bear left (S) and proceed for 0.55 miles, passing junction to left (SE); proceed another 0.55 miles to a wash (be careful on S. side wash coming out—narrow-tracks); continue another 0.60 miles along N-S fenceline to a point SW 300' from station.

CORNER NO. 9

Tps. 23 and 24 N., Rs. 5 and 6 W.



3" I.P. w/B.C.

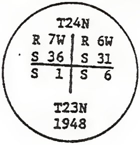
Proj. 8" above gnd., located in N-S fenceline on N. slope; moderate timber E. and W.; slight verticals (3-10"); trees possibly a problem; mast possibly necessary; fairly good window.

To Reach Cor. No. 9

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

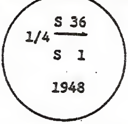
Head ESE on Hwy. 44 for 5.80 miles to the major dirt road, heading N. out of Counselor (past Counselor Post on N. side); turn left and proceed N. on dirt road, for 5.65 miles, to a junction with dirt road to right (E.); head E. and S. on this road (past gas wells) and up hill to top, for 1.30 miles; bear left, (NE) across another dirt road, and follow 2-track trail for 0.60 miles to W. side of N-S fenceline; turn left (N.) and proceed 0.10 miles to a point S. 200' from station.

CORNER NO. 10
Tps. 23 and 24 N., Rs. 6 and 7 W.



3" I.P. w/B.C.
proj. 16" above gnd. in scattered mnd. of stone; located on steep, rocky N. slope; moderate timber; steep verticals to S. and E. (75°); mast necessary; bad window.

ALTERNATE: 1/4 sec. cor. of secs. 1 and 36, Tps. 23 and 24 N., R. 7 W.



1" I.P. w/B.C.
Proj. 6" above gnd. located in open sage between deep-cut washes in valley; no timber; slight verticals (8°) E., W. and S., no mast necessary, good window.

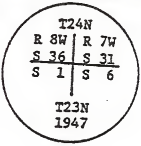
To Reach Cor. No. 10 (Alternate)

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

Head ESE on Hwy. 44 for 0.55 miles to the major dirt road heading N. (past gas company on N.); turn left and head NE along main road for 2.75 miles; station is W. 300' (dirt road to right (E.) at this point).

CORNER NO. 11

Tps. 23 and 24 N., Rs. 7 and 8 W.



3" I.P. w/B.C.
Proj. 2" above gnd., located in open sage field at fence post corner, lines E-W and S., no mast necessary; sparse timber; slight verticals (4°), good window.

To Reach Cor. No. 11

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

Head WNW on Hwy. 44 for 5.05 miles to a major dirt road heading N.; turn right and head N. for 0.55 miles across wash, to 2-track dirt road to right (E.); head E. on this road for 0.50 miles, past car junkyard on right (S.); turn right (S) and head for oil pump jack, 0.15 miles; station is SW 700' from here.

CORNER NO. 12
Tps. 23 and 24 N., Rs. 8 and 9 W.

T24N

R 9W	R 8W
S 36	S 31
S 1	S 6

T23N
1933

3" I.P. w/B.C.
Proj. 12" above gnd., located on gently rolling terrain in open sage, in E-W fenceline; very slight verticals; sparse timber N. and S., no mast necessary; good window.

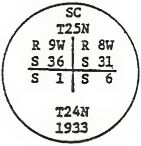
To Reach Cor. No. 12

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

Head WNW on Hwy. 44 for 12.15 miles to a dirt road, to the right (E.); turn right, head E. past old building on left (N) for 0.75 miles to a gas sign (No. 380); cut back W., on S. side of E-W fenceline, and proceed 0.30 miles to station on right (N.).

CORNER NO. 13

Tps. 24 and 25 N., Rs. 8 and 9 W.



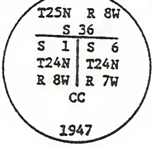
3" I.P. w/B.C.
Flush w/gnd. in N-S fenceline, 10' S. of intersection W/E-W fenceline; located in open sage field E. of sandy wash, slight verticals (4°) N. and E., no mast necessary; good window.

To Reach Cor. No. 13

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

Head WNW on Hwy. 44 for 17.70 miles, to a dirt road, to the right (N.); head N. on this road, and bear to left at 0.25 miles, continue N. and E. to sandy wash, another 1.45 miles; continue E. for 0.75 miles to windmill on right (S.); bear left (NE) and proceed 0.40 miles to the Arviso Ranch private gate; (depending on forthcoming permission - roads inside gate will lead to station 1 mile NE from gate).

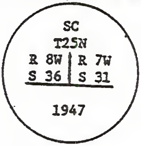
CORNER NO. 14
C.C. T. 24 N., Rs. 7 and 8 W.



3" I.P. w/B.C.
Proj. 6" above gnd., located on gentle W. slope in moderate timber; slight verticals (5° to S.); mast necessary; <u>fairly good window.</u>

"OR"

S.C. T. 25 N., Rs. 7 and 8 W.



3" I.P. w/B.C.
Proj. 6" above gnd., located on gentle W. slope in moderate timber, slight verticals (5° to S.); possibly mast necessary; <u>fairly good window.</u>

To Reach Cor. No. 14

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

Head WNW on Hwy. 44 for 1.65 miles to a dirt road to the right (N.); turn right and head N. for 1.50 miles to a junction with a road to the left; bear left (N.) past oil well on right and continue along dirt road for 2.40 miles to very top of hill (Brooks on left); proceed along main dirt road another 2.75 miles to the BCO camp and oil tanks on right (E.); continue on main road another 2.60 miles to a junction with another dirt road; bear straight ahead (NW) and continue for another 0.70 miles to a dirt road to the right (N.); turn right and head N. and E., for 1.15 miles to an oil jack; station is NW 800' from here; (SC and CC 200' apart).

CORNER NO. 15

C.C. T. 24 N., Rs. 6 and 7 W.

T25N

S 1 | S 6
R 7W | R 6W

T24N

CC

1964

2 1/2" I.P. w/B.C.
Proj. 4" above gnd., located in open sage; no timber, between deep-cut washes; slight verticals N. and S. (8°) mast not necessary, good window.

OR

S.C. T. 25 N., Rs. 6 and 7 W.

SC

T25N

R 7W | R 6W
S 36 | S 31

1964

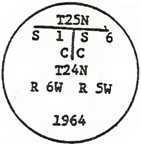
2 1/2" I.P. w/B.C.
Proj. 4" above gnd., located in open sage; no timber; between deep cut washes (on N. side of one), slight verticals N. and S. (10°), mast not necessary, good window.

To Reach Cor. No. 15

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

Head ESE on Hwy. 44 for 0.55 miles to the major dirt road heading N. (past gas company on N.); turn left and head NE along main road for 10.10 miles to junction with another dirt road; turn left (N.) past oil tanks, etc. on W. side and proceed 0.80 miles to a dirt road on left (W.); turn left and head WSW on the N. side of Rockhouse Canyon for 2.80 miles to a junction with a dirt road to the right (NW); turn right and proceed for 0.60 miles to a point NE 350' from station. (SC and CC 200' apart). (optional roads N. out of Counselor - see quads).

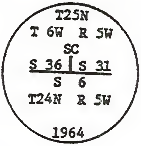
CORNER NO. 16
C.C. T. 24 N., Rs. 5 and 6 W.



2 1/2" I.P. w/B.C.
Proj. 4" above gnd; mnd. of stone to S., located on broken ground, S. of cliff in scattered timber, 50' N. of fence corner, lines E. and S., sharp verticals N. and W., not so good window.

OR

S.C. T. 25 N., Rs. 5 and 6 W.



2 1/2" I.P. w/B.C.
Proj. 6" above gnd., located SE of fence post corner, lines N. and W., in scattered timber; slight verticals (5°) good window.

To Reach Cor. No. 16

From the Chevron sign at Lybrook Mercantile, on the S. side of Highway 44 in Lybrooks:

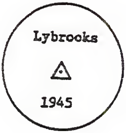
Head ESE on Hwy. 44 for 5.80 miles to the major dirt road heading N. out of Counselor (past Counselor Post on N. side), turn left and proceed N. on dirt road, for 8.75 miles and junction, bear right (NE) around N. tip of mesa, and continue for 0.70 miles across wash, to a N-S fenceline and Jicarilla Indian Reservation sign, continue for 0.10 miles and bear left (road J-18), head E. and N. on this main dirt road for 4.20 miles to a major junction (gas pipes on right, E), turn left and head W. on this major dirt road for 2.80 miles to the Jicarilla Indian Reservation fence and sign; turn left (S.) before fence (on E. side) and go 0.20 miles; bear left and wind down (S.) 2-track trail for 0.40 miles at base of hill; turn right (W.) and go 0.10 miles to station on right (N.) at fence corner; (SC and CC 200' apart).

Optional roads N. out of Lybrooks - (see quads)

OR

From Jicarilla Indian Reservation sign past wash (before road J-18 in above description) head NW on main dirt road for 2.10 miles to a road to right (N.); turn right and wind uphill for 2.50 miles to a major junction, turn right (E.) and go 0.50 miles to the Jicarilla Indian Reservation fence and sign, turn right past N-S fence, continue above description.

A. Lybrooks



Standard bronze disk on top of 2" I.P.
Proj. 6" above ground
Fnd. 2 ref. marks as desc.

Located on top of peak, due S. of tallest tower of microwave complex, just S. of gray shed.

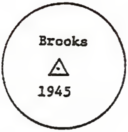
Trees and towers present possible problems; mast necessary; very slight verticals (2°).
Not a very good window

"TO REACH":

From the Chevron sign at Lybrook Mercantile, on the S. side of Hwy. 44 in Lybrooks:

Head WNW on Hwy. 44 for 0.75 miles to a road to the left (S.); turn left and continue on this dirt road for 1.80 miles (bear left all the way) to the top of hill and microwave/radio towers and station.

B. Brooks



Standard bronze disk on top of 2" I.P. Proj. 8" above ground.

Fnd. 2 ref. marks as desc. very slight verticals (2°); located in scattered timber, no mast necessary.
Good window

"TO REACH":

From the Chevron sign at Lybrook Mercantile on the S. side of Hwy 44 in Lybrooks:

Head WNW on Hwy 44 for 1.65 miles to a dirt road to the right (N); turn right and head N. for 1.50 miles to a jct. with a road to the left (N); bear left past oil well on right, and continue along dirt road for 2.40 miles to very top of hill; turn left (W) on 2-track trail, for .05 miles and station on left.

C. CROW

CROW
△
1945

Standard bronze disk set flush w/bedrock
Fnd. 2 ref. mks. as desc.
Scattered timber; possibly mast necessary;
located on top of mesa; 0° verticals.
Good window

"TO REACH":

From the Chevron sign at Lybrook Mercantile, on the S. side of Hwy. 44 in Lybrooks:

Head WNW on Hwy. 44 for 1.65 miles to a dirt road to the right (N); turn right and head N. for 1.50 miles to a jct. with a road to the left (N); bear left past oil well on right and continue along dirt rd. for 2.40 miles to very top of hill (△ Brooks on left); proceed along main dirt road for another 2.75 miles to the BCO camp and oil tanks on right (E); continue on main dirt road another 2.60 miles to a jct. with another dirt road; bear straight ahead (NW) and continue for 1.55 miles to a jct. with a dirt road to the right (N); turn right and go N. for 0.20 miles and station to left.

D. LOCK

Station mark missing; 12" concrete base intact-proj. 2" above gnd.; Fnd. 2 ref. marks as desc.

Scattered low timber; possibly mast necessary; very slight verticals (2°)

Good window

"TO REACH":

From the Chevron sign at Lybrook Mercantile, on the S. side of Hwy. 44 in Lybrooks:

Head ESE on Hwy. 44 for 5.90 miles to the dirt road heading S. out of Counselor; turn right and proceed S. on the main dirt road for 4.6 miles to a major jct; continue straight on main road heading SW for 2.10 miles, just past a dirt road to left (E.); turn right and double back toward flags for 0.10 miles and station.

E. UNION

Station mark missing;
Fnd. 2 ref. marks as desc.

Located on sandy knoll in sage; scattered timber; possibly mast necessary; very slight verticals (2°).

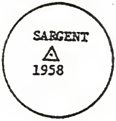
Good window

"TO REACH":

From the Chevron sign at Lybrook Mercantile, on the S. side of Hwy. 44 in Lybrooks:

Head ESE on Hwy. 44 for 5.90 miles to the dirt road heading S. out of Counselor, turn right and proceed S. on this main dirt road for 4.6 miles to a major jct.; continue straight on main road, leading SW for another 12.1 miles to a major jct. (radio tower to E.; signs to Star Lake Plant, Pueblo Pintado, etc.); turn right and head NW for 1.10 miles to a road to left (SW); turn left on this 2-track dirt road (bear left, S.) for 0.60 miles; then bear right and head to top of small hill, 0.35 miles and station.

F. SARGENT



Standard bronze disk on top of 2" IP proj. 6" above gnd.
Fnd. 2 ref. mks. as desc.
Located in open sage/grass on top of small rise; 70' S. of E-W fence line, W. of dirt road.

Very slight verticals (1°); no timber, no mast necessary;
<u>Good window</u>

"TO REACH":

From the Chevron sign at Lybrook Mercantile on the S. side of Hwy. 44 in Lybrooks:

Head WNW, then SW on Hwy. 44 for 9.50 miles to a major dirt rd. to left (S) just W. of Hwy. 44 7-11 store; thence head S. on this rd. for 11.35 miles to a rd. to the right (W); turn right and head W. on this 2-track dirt rd. for 1.75 miles to gate in E.W. fence line; go thru gate and turn right (W.) cross country for .05 miles on S. side fence line, and station.

G. NAGEEZI

Standard bronze disk set flush in 12" sq. concrete base, proj. 6" above ground.

Fnd. 1 ref. mk. undisturbed, other disturbed;

Located on W. cut slope, 55' perpendicular (E.) from and paved Hwy. 44 and 30' W. of R.O.W. fence line (E. side of rd.).
No timber, slight vertical E. due to cut bank, possibly mast necessary;
Good window.

"TO REACH":

From the Chevron sign at Lybrook Mercantile, on the S. side of Hwy 44 in Lybrooks:

Head WNW on Hwy. 44 for 12.55 miles and station on right (E.), small town of Nageezi and store on left (W.).

H. AKIN

Standard Bronze set flush in 12" sq. concrete base, proj. 4" above gnd. Fnd. 2 ref. mks. as desc.

Located within triangle of dirt rds. (20' N. of E.W. dirt rd.) in open sage, no timber.

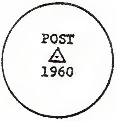
Very slight verticals (1°)
No mast necessary
Good window

"TO REACH":

From the Chevron sign at Lybrook Mercantile, on the S. side of Hwy. 44 in Lybrooks:

Head W.N.W. on Hwy 44 for 9.50 miles to a major dirt rd. to left (S), just W. of Hwy. 44 7-11 store; turn left (S.) and go 5.20 miles on main rd. to a rd. to the right (W.), turn right and go .10 miles, station on right (N.).

I. POST



Standard bronze disc set flush in 12" sq. concrete base, proj. 2", located on top of knoll 2,000' N. of Hwy. 44 in moderate timber; mast necessary; verticals very slight except for tree blockage;

Fairly good window

"TO REACH":

From the Chevron sign at Lybrook Mercantile on the S. side of Hwy. 44 in Lybrooks:

Head E.S.E. on Hwy. 44 for 1.60 miles; station is 2,000' N. of this pt. - flagged telephone pole N. of R.O.W. fence, on line to station.

Station mark missing;
Fnd. 2 ref. mks. as desc.

Located on sandy knoll, 12' E. of dirt trail rd. in scattered timber; mast may be necessary; slight verticals (5°)

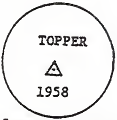
Good window

"TO REACH":

From the Chevron sign at Lybrook Mercantile, on the S. side of Hwy. 44 in Lybrooks.

Head E.S.E. on Hwy. 44 for 5.90 miles to the dirt rd. leading S. out of Counselor, turn right (S.) and proceed for 1.70 miles to a dirt rd. to left (E.); turn left and continue for 1.0 miles on the main 2-track dirt trail, across wash, to a jct. with dirt trail to right (S.); bear S & E; continue for 0.45 miles to top of hill and jct. with rd. to S. turn right (S.) and go .05 miles to station on left (E.).

K. TOPPER



Standard bronze disk set flush in bedrock; Fnd. 1 ref. mk. as desc.; other not fnd;

Located on top of rocky knoll in scattered timber; verticals very slight (3°) without tree blockage; possibly mast necessary; fairly good window.

L. APACHE

APACHE

△

1958

Standard bronze disk set flush in 12" sq. concrete base, proj. 1";

Located on top of small hill 300' W. of dirt road; no timber; very slight verticals E. (3°). No mast necessary;
Good window

"TO REACH": K. TOPPER L. APACHE

Refer to quads and △ data sheets (no mileages gaged at this time)
Also △ OTERO maybe of value to search

APPENDIX D

Table 1: Elapsed Time

Action	Auto	Manual	Result
Read in PCCS Coordinate file and generate land lines with PCCS2ADS.	36 sec.	60 min.	Township and sections ADS raw line file.
Assign section attributes and create polygone files.	15 min. 10 sec.	15 min. 10 sec.	Closed polygon file with attribute assignments.
Read STATUS file into PARCEL and generate line and attribute file.	15 min. 8 sec.	240 min.	Raw line map of status with attribute placement.
Close polygon and assign attributes for STATUS.	21 min. 41 sec.	21 min. 41 sec.	Closed polygon map of STATUS with assigned attributes.
Read lease file into PARCEL from Case Recordation.	8 min. 11 sec.	560 min.	Rawline map with attribute placement for oil and gas leases.
Close polygon and assign attributes to leases.	13 min. 38 sec.	13 min. 38 sec.	Closed polygon map of lease with assigned attributes.
Read in KGS files to PARCEL.	2 min. 32 sec.	30 min.	Rawline map and attribute assignment in ADS.
Close polygon for KGS boundaries.	3 min. 18 sec.	3 min. 18 sec.	Closed polygon map with attribute assignment in ADS.
Read units into PARCEL	24 sec.	30 min.	Rawline map and attribute placement for units.
Close polygons for units.	47 sec.	47 sec.	Closed polygon map with attribute assignment for units.
Read Comms into PARCEL	28 sec.	30 min.	Rawline map with attribute assignment for Comms.
Close polygons for Comms.	1 min. 21 sec.	1 min. 21 sec.	Closed polygon map with attribute assignments for Comms.
Generate well locations in ADS with GFWL.	15 min.	60 min.	Symbol map with attribute assignment for well locations.
TOTAL:	1 hr. 37 min.	16 hrs. 45 min. 55 sec.	

Table 2: Total Time

Total Themes	Auto	Manual	Total Software
1. PLSS	1 hour	16 hours	ADS
2. STATUS	37 min.	45 min. 55 sec.	PARCEL
3. O&G Leases	18 sec.		GGWL PCCS2ADS
4. KGS			
5. UNITS			
6. Comms	1 hour		PLSS
7. Well Locations	1 hour		

Acronyms and Abbreviations

ADS	—	Automated Digitizing System
ALMRS	—	Automated Land and Mineral Record System
ANSI	—	American National Standards Institute
AOS	—	Advanced Operating System
APD	—	Application for Permit to Drill
ARRS	—	Automated Resource Requirements Study
ASCII	—	American Standard Code for Information Interchange
Bureau	—	U.S. Department of the Interior, Bureau of Land Management
CA	—	Communitization Agreement
CASO	—	California State Office
COSO	—	Colorado State Office
CLI	—	Command Line Interpreter
CPL	—	Command Programming Language
DEMs	—	Digital Elevation Models
DG	—	Data General
ESRI	—	Environmental Systems Research Inc.
GGWL	—	Generate Geographic Well Location
GIS	—	Geographic Information Systems
HP	—	Hewlett Packard
IDIMS	—	Interactive Digital Image Analysis System
INTGGWL	—	Interactive Generation of Geographic Well Location
KGS	—	Known Geologic Structure
LIS	—	Land Information System
LLD	—	Legal Land Descriptions
MAP	—	Map Analysis Package
MOSS	—	Map Overlay and Statistical System
NMSO	—	New Mexico State Office
ORSO	—	Oregon State Office
PCCS	—	Public (land survey) Coordinate Computation System
PCCS2ADS	—	Public land survey Coordinate Computation System to Automated Digitizing System (conversion)
PGFORMAT	—	Parcel Generator Format
PI	—	Petroleum Information, Inc.
PLSS	—	Public Land Survey System

RA -- Resource Area

RDBMS -- Relational Data Base Management System

SC -- Service Center

SED -- Screen Editor

UA -- Unitized Agreement

USGS -- U.S. Department of the Interior, Geological Survey

WYSO -- Wyoming State Office

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